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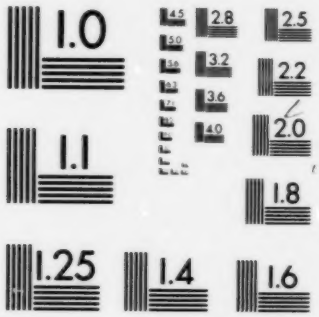

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REPORT OF INVESTIGATION INTO THE CIRCUMSTANCES ATTENDING THE CAPSIZING OF THE CANADIAN FISHING VESSEL "MISS JOYE", OFF EGG ISLAND, BRITISH COLUMBIA, ON JULY 24, 1986 AND AGAIN IN SEYMOUR NARROWS, BRITISH COLUMBIA, DECEMBER 7, 1986

REPORT No. 476

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REPORT OF INVESTIGATION INTO THE CIRCUMSTANCES ATTENDING THE CAPSIZING OF THE CANADIAN FISHING VESSEL "MISS JOYE", OFF EGG ISLAND, BRITISH COLUMBIA, ON JULY 24, 1986 AND AGAIN IN SEYMOUR NARROWS, BRITISH COLUMBIA, DECEMBER 7, 1986.

Particulars of Vessel

Name	"MISS JOYE"
Official Number	346316
Port of Registry	Vancouver, British Columbia
Call Sign	CZ 2238
Gross Tonnage	39
Net Tonnage	28
Length- Overall	17.68 m
Length- Registered	15.55 m
Breadth- Moulded	5.03 m
Depth- Moulded	2.82 m
Type of Vessel	Small Fishing Vessel, Seiner
Material	Wood
Built	1971, Frostaad Boatworks Ltd., Delta, B.C.
Propulsion	Caterpillar diesel, 6 cylinder, Model 334, 236 b.h.p. single fixed-pitch propeller
Owners	James W. Walkus Fishing Co., Nanoose Bay, B.C.

Navigating Equipment on board July, 1986

Radar	Furuno, Model FRS-36E
Echo Sounder	Furuno, Model F861B
VHF Radiotelephone	Hy-seas, Hy Gain, 55 Channel
SSB Radiotelephone	Daniels, Model DE-1100
Magnetic Compasses (2)	Wagner, Saura, 5" diameter, in wheel-house, Danforth

	Constellation, on flying bridge
Communications Receiver (2)	Yaesu, Model FRG 7000 Icom, Model K-V100 with frequency programmer EX-494
Auto Pilot	Wagner Mk4

Navigating Equipment on board, December, 1986

Radar	Furuno, Model FR-803D
Echo Sounder (2)	Furuno Colour Video Sounder, Model FCV-501 Furuno, paper recorder model
VHF Radiotelephone (2)	ICOM, Model IC-V100 ICOM, Model IC-M55
SSB Radiotelephone	ICOM, Model IC-M700
Magnetic Compass (2)	Wagner, 5" diameter, in wheel-house; Danforth Constellation on flying bridge.
Auto Pilot	Wagner, Mk 4

Life Saving Equipment

Liferaft (1)	Beaufort inflatable, 6 person, Model "A" pack
Lifeboat (1)	Seine skiff, aluminum, 6 person
Lifebuoys (3)	
Lifejackets (6)	D.O.T. Standard

The "MISS JOYE" is a carvel-built wooden fishing vessel of closed construction and round bilge form, designed and built by the Frostaad Boatworks of Delta, B.C. in 1971, for the James Walkus Fishing Company. The vessel's deck-house, wheel-house, crew accommodation and engine-room are located forward of amidships and the fish hold compartments and lazaret space aft of amidships.

The vessel can be operated from either the wheel-house or the flying bridge above the wheel-house. The flying bridge is equipped with a throttle and gear shift, a jog steering tiller, steering wheel, rudder angle indicator and a

magnetic compass.

Under the requirements of the Small Fishing Vessel Inspection Regulations, the "MISS JOYE" is subject to inspection every four years by the Ship Safety Branch of the Canadian Coast Guard; her last periodic survey was performed while the vessel was in drydock at New Westminster, B.C., June 1986 and completed at Port Hardy, B.C., July 9, 1986.

The vessel is certificated as a Home Trade Class II vessel and her Steamship Inspection Certificate, SIC 29, was issued July 9, 1986 with an expiry date of June 11, 1990.

The "MISS JOYE" was surveyed for insurance purposes on October 31, 1985, at which time she was described as being well maintained.

Background

During the evening of July 24, 1986 the seine net fishing vessel "MISS JOYE", heavily trimmed by the stern with a full load of salmon on board, was southbound from Ogden Channel to the fish plant at Port Hardy, B.C., when the vessel shipped seas on deck and heeled over to starboard until she lay on her beam ends.

The vessel was abandoned off Egg Island and the 6 persons on board were rescued by another fishing vessel which was in the immediate area.

The "MISS JOYE" was later salvaged and towed to Port Hardy for a damage survey before being refitted in Campbell River.

There were no injuries nor was there any appreciable pollution as a result of this casualty. The cost of repairs was estimated to be in the order of $140,000.

During the afternoon of December 7, 1986, "MISS JOYE" departed from Campbell River, B.C., in a lightly loaded condition with her seine net on the drum, bound for winter lay-up in Port Hardy.

That same day, whilst transitting Seymour Narrows in good weather conditions, at about the time of maximum ebb flow, the vessel, influenced by the current, lost steerage and heeled over to starboard until she lay on her beam ends and eventually capsized.

The crew remained on the overturned hull as the vessel continued to drift northwards through the narrows until they

were rescued shortly afterwards by another northbound fishing vessel.

The "MISS JOYE" was later salvaged and towed to Brown Bay for a damage survey before being towed to French Creek for repairs. No cost estimate was available for these repairs.

There were no injuries nor was there any appreciable pollution as a result of this casualty.

Prior to the recent capsizes, on the morning of November 28, 1977, in good weather conditions, the "MISS JOYE" was approaching Seymour Narrows at the time of maximum ebb flow when she heeled over to port and capsized. Three persons lost their lives as a result of this incident. The vessel was subsequently salvaged, repaired and returned to service. The cost of repairs was estimated to be in the order of $100,000.

Part I

Note: All times in Part I of this report are expressed in Pacific Daylight Saving Time (UTC minus 7 hours).

Narrative

The small seine net fishing vessel "MISS JOYE" departed from Port Hardy, British Columbia at 2230, July 19, 1986 with 6 persons on board including the skipper and one guest. The vessel was on her second salmon fishing trip of the 1986 season and was bound for fishing regulatory area 8-2 in Haku Passage to take part in the salmon fishery opening due to commence at 1800, July 20, 1986.

The "MISS JOYE" sailed with her fresh water tank full and with a total of approximately 5,600 litres (1231 gallons) of diesel oil in her engine-room diesel tanks. The vessel also carried 3 tonnes of ice in her fish hold compartments and she had a 6 person seine skiff and a seine net stowed at the stern.

The "MISS JOYE" experienced good weather and had an uneventful trip through the Queen Charlotte Strait and north to the fishing area.

The vessel fished in regulatory area 8-2 until July 22 at noon, at which time, with a catch of approximately 4500 head of salmon on board, it was decided to head north to regulatory area 5-2 in the Ogden Channel to take advantage of

a 24 hour fishing extension in that area. The salmon was stowed in the forward port and starboard fish holds.

The "MISS JOYE" departed from area 8-2 shortly after noon, July 22 and, as some difficulties had been experienced with her radar set, she travelled through the inland waterways to Ogden Channel in company with the fishing vessel "ISLAND JOYE" which was owned by the same company.

Both vessels had an uneventful passage en route and arrived in Ogden Channel at approximately 1100, July 23. The "MISS JOYE" commenced fishing at 1200 and made about five or six sets before the close of the regulated fishing period at 1800 that same day.

As neither the "MISS JOYE" nor the "ISLAND JOYE" had a full load of fish on board, it was decided by both skippers to transfer the catch from the "ISLAND JOYE" to the "MISS JOYE" and the latter vessel would then return to the fish plant at Port Hardy thereby allowing the "ISLAND JOYE" to remain in the general area and resume fishing the following week at the next opening.

The crew of both vessels transferred approximately 4,300 head of fish from the "ISLAND JOYE" to the after fish hold of the "MISS JOYE", packed some ice on top and filled the tank with sea water to the level of the bottom of the hatch coaming. The port and starboard forward fish holds were similarly stowed with fish, ice and sea water and filled to the level of the bottom of the hatch coaming. With this information, it was estimated that the vessel had on board 17,618 kg of salmon and 16,484 kg of salt-water and that the draught was 2.59 m forward and 3.68 m aft.

After transferring the fish, the crew secured the main hatch and lowered the boom to its stowed position resting on the seine drum. The seine net was wound around the drum and the seine skiff was stowed athwartship on the stern. Being in all respects secured for sea and with her radar set operational again, the "MISS JOYE" departed from Ogden Channel at 2030, July 23 and headed south for Port Hardy via the inland waterways as far as Cape Calvert.

Whilst underway the crew maintained three and a-half hour wheel-house watches.

When heavily loaded and trimmed by the stern, the "MISS JOYE" routinely shipped water on the afterdeck, some of which would be retained and which would gain access to the lazaret space by way of the uncaulked openings around the fuel tank and fresh water tank air pipe deck penetrations. When this

occurred, it had become the normal practice on board to pump out the lazaret space every three to four hours.

The "MISS JOYE" departed from Ogden Channel with approximately 9.5 cm (3 3/4 in) of freeboard amidships.

Whilst traversing the inland waterways it was reported that the vessel was taking light seas on her afterdeck amounting to approximately 5 cm (2 in) of water which would eventually run off through the freeing ports.

The "MISS JOYE" arrived off Cape Calvert and entered open waters at approximately 1845, July 24 and proceeded in a southerly direction at her full load service speed of 7.5 knots at 1,850 rpm. Navigation was by local knowledge and radar distances off known points of land; no positions were being plotted on the chart nor were any pre-plotted courses being steered.

At 1900, the wheel-house watch was changed and the vessel was being steered in the automatic pilot mode on a course to clear Egg Island. The course was set in accordance with distances off Egg Island and Cape Caution.

Also, at 1900, the engineer pumped the lazaret space until the pump lost suction at which time it was assumed that the space was dry. It was not possible to look down into the space as the seine skiff was stowed on top of the manhole.

Once clear of Cape Calvert, the "MISS JOYE" began shipping more seas on the afterdeck, the amount progressively increasing as the vessel continued southward. As she was riding comfortably in the seaway with only a slight pitching motion, it was not considered necessary to deploy the roll-reducing paravanes (stabilizers).

At approximately 2000, July 24, it was decided to pump out the lazaret space again as an accumulated amount of sea water was being retained on the afterdeck. Shortly after starting the pump, the vessel developed a starboard list and lay over at an angle of 10°-15°.

With the exception of the watchkeeper, all those on board were in the galley at this time and able to observe the afterdeck through the galley doorway and window.

Weather conditions existing at the time were clear with:

Wind - West to south-west at 25 knots
Sea - 0.6 m Swell - Low to moderate NW'ly
Visibility - 10-12 nautical miles

After pumping out the lazaret for three to four minutes, the skipper instructed the engineer to commence pumping out the after fish hold. However, after a few more minutes it became apparent that the vessel was listing still more to starboard and the stern was noticeably lower in the water. It was therefore decided to cease pumping out the after fish hold and commence pumping out the starboard forward hold; the engine-room bilges were inspected and found to be dry at this time.

The skipper, who was directing operations from the main deck, then ordered an alteration of course to starboard and a reduction of speed to bring the vessel head to wind.

After pumping out the starboard forward hold for a further two to three minutes, it was thought that the vessel was righting herself satisfactorily so the order was given to cease pumping that hold and resume pumping out the after hold.

At about this period in time lifejackets were distributed to all on board.

An alteration of course to port was then ordered to bring the vessel back on her original course, at which time the list began increasing to starboard again and continued to an alarming 35°-40°.

The skipper made his way to the wheel-house and assumed the conduct of the vessel. He increased speed to 1,850 rpm and, after reverting to the hand steering mode, applied port helm intending to head for shelter behind Egg Island. The vessel, however, did not respond to the helm but began swinging to starboard instead. The engine then began spluttering and dropped to about half revolutions.

The crew and guest assembled in the wheel-house and at 2032 a 'MAYDAY' was broadcast on VHF radiotelephone, channel 78A, but there was no reply. The skipper then ordered all hands to evacuate the wheel-house through the port wheel-house door and to prepare and board the liferaft. Two crew members brought the liferaft from the flying bridge and it was inflated over the port side and boarded by all except the skipper.

At this time it was observed that the stern was submerged so much that seas had already swamped the skiff and partially displaced the hatch tarpaulin and some wooden hatch boards, leaving the fish holds exposed. The list was such that seas were coming over the starboard bulwark and the water level was just below the galley door and windows.

After assessing the situation, the skipper exited through the port wheel-house door, leaving the engine and pump running, and proceeded along the vessel's port side to the liferaft. At this time no flood water had entered the engine-room or accommodation spaces.

The "MISS JOYE" was abandoned at about 2038, July 24, 1986 in approximate position 51°15.3'N, 127°51.5'W which is 7 cables west by north of Egg Island. Not knowing if their 'MAYDAY' call had been heard, the crew kept the liferaft in the vicinity of the "MISS JOYE" and fired off a distress rocket. The "MISS JOYE" continued listing until she was on her beam ends.

The "MISS JOYE"s 'MAYDAY' message was, in fact, received by the fishing vessel "HIGH VENTURE" in a rather broken transmission. The "HIGH VENTURE" relayed the message to the Bull Harbour Coast Guard Radio Station (CGRS) who, in turn, issued a 'MAYDAY' relay and reported the incident to Rescue Coordination Centre, Victoria, (RCC).

RCC Victoria tasked the Bull Harbour lifeboat, the passenger ferry "QUEEN OF THE NORTH" and the two fishing vessels "HIGH VENTURE" and "GYPSY DANCER" which were in the area.

At 2040 the "GYPSY DANCER" reported sighting the "MISS JOYE" and thought her to be on fire however, a closer inspection revealed that the heavy smoke was coming from the vessel's exhaust as the engine was still running.

At 2056, July 24, the "GYPSY DANCER" reported all 6 survivors were safely on board and none were injured. The 'MAYDAY' relay was cancelled at 2100 and all search vessels were stood down.

The 'MISS JOYE" was later towed, in the capsized condition, to Smith Inlet where she was righted and towed to Port Hardy, arriving on the morning of July 27, 1986. The vessel was later towed to Campbell River where she underwent a refit and returned to service as a salmon seiner August 31, 1986. The vessel subsequently underwent an inclining experiment at Campbell River, B.C., November 6, 1986.

Analysis

1. Access Hatches

Manholes to the lazaret space and to the fish tanks were of an approved design and were flush with the deck. They were of aluminum alloy construction with a cross-bar

locking device, key operated on the outside; all were secured at the time of the incident.

Main Cargo Hatch

The main hatch was covered with wooden hatch-boards over which one tarpaulin was draped. The tarpaulin was secured by wooden side battens; batten-securing wedges were not fitted. Both the tarpaulin and hatch-boards were partially displaced by seas washing against the after end of the hatch at the time of the casualty and eventually displaced by the impact of the fish as the vessel heeled further to starboard.

2. Mechanical Equipment

It was reported that both the main engine and steering gear were operating in a satisfactory manner until the vessel was heavily listed and visibly sinking aft. At that time, the engine spluttered and dropped in revolutions but did not stall and the vessel would not respond to the helm.

3. Lazaret

After the vessel was salvaged, an inspection revealed that approximately 9 metres (30 ft) of braided 5.08 cm (2 in) line and approximately 6 metres (20 ft) of 2.54 cm (1 in) purse line, were stowed in the lazaret space over the bilge suction. The deck penetration fitting of the gooseneck air pipe, from the empty port side diesel fuel oil tank in the lazaret space, was not caulked and there was an opening of approximately 1 cm in width all around the pipe. Similarly, on the starboard side, the deck penetration around the gooseneck air pipe from the fresh water tank, required caulking.

4. Engine-room Pumps

The vessel was equipped with the following pumps:

Fire/Bilge pump	15 litres per second, 51 mm diameter pump, driven by a hydraulic power take-off on the main engine, capable of drawing from all watertight spaces i.e., lazaret, engine-room, all fish hold compartments and accommodation.
Bilge pump	15 litres per second, 31 mm diameter Monarch pump, hydraulically driven by hydraulic power from the power take-off

on the main engine.

Auxiliary Pump	A Pump and Power hydraulic pump with hand operating capabilities, located on deck and for fish hold use. 51 mm diameter

The main fire/bilge pump was used at the time of the casualty.

5. Stability

(a) As a small fishing vessel of more than 15 gross tons built before July 6, 1977, and not engaged in fishing for herring or capelin at the time of the casualty, the "MISS JOYE" was not required to comply with the stability requirements of Part 1, Section 29, of the Small Fishing Vessel Inspection Regulations. Regulatory approval is based upon compliance with criteria detailed in Canadian Coast Guard 'Stability, Sub-division and Load Line Standards', STAB 4. Although the "MISS JOYE" was not required to comply with these requirements, they are considered to be the most appropriate 'yardstick' against which the stability characteristics of fishing vessels of this size may be assessed - notwithstanding the mode of fishing in which they may be employed.

The actual criteria contained in STAB 4., are listed in Annex 1 of this report and a direct comparison between the minimum values required and the results of the post casualty stability analysis of the "MISS JOYE" are included in Part 3, 'Stability Evaluation'.

(b) The loading conditions compiled as part of the post-casualty stability analysis of the "MISS JOYE" incorporate the distribution of fishing gear, fish catch and preservation water, oil fuel, fresh water and other consumables reportedly on board at the time of the casualty, and are based upon the hold, tanks, hydro-static and righting lever (KN) curves, and basic data included in the vessel's Trim and Stability Booklet, which was approved June 6, 1978.

(c) The reported disposition of weights on board the vessel at the time of the capsize is listed as follows:

Oil fuel (60%*)	3.86 tonnes	Engine-room tanks (P&S)
Fresh water (10%*)	0.25 "	F.W.tank aft (S.)
Misc. gear & spares	0.20 "	Lazaret

Misc. fishing equip.	0.15	tonnes	On main deck
Provisions, etc.	0.15	"	In galley & stores
Crew & effects	0.45	"	In accommodation
Seine net & gear	5.08	"	Wound on drum
Seine skiff (Alloy)	0.27	"	Stowed at stern
Storage ice	3.05	"	Fish holds (3)
Salmon catch *(9,500 'head')	17.62	"	Fish holds (3)
Preservation & 'make-up'- seawater	16.48	"	Fish holds & hatches (3)

*approximate

These items are the 'reported best estimate' of the distribution of the deadweight on board the vessel shortly before she capsized.

(d) The vessel's current lightship weight and characteristics were verified from an inclining experiment carried out with the cooperation of the owner, November 6, 1986, as part of the casualty investigation process, and are incorporated in the casualty loading conditions.

It should be noted that since the approved Trim and Stability Booklet was prepared in 1978, the vessel's lightship characteristics have changed; the current and original details are listed for comparison:

Date Inclined	Lightship Wt	VCG	LCG
Feb 20, 1978	46.10 tonnes	2.75 m	9.22 m
Nov 06, 1986	50.89 tonnes	2.89 m	9.32 m

As the 1978 lightship weight included a seine skiff of 0.27 tonnes, direct comparison shows an actual increase of 5.06 tonnes, part of which can be accounted for by the following 'known' changes and normal weight accumulation during the previous 8 1/2 years service:

'Known'/Accumulated Items	Estimated Wt.
Fish hold & hatch permanent division bulkheads	= 1.12 tonnes
Keel and skeg scarfing piece	= 0.30 "
Storage locker & spares on deck-house top	= 0.36 "
Spare towing pin on deck-house top	= 0.10 "
Heavier main boom & fittings	= 0.41 "
8 1/2 yrs accumulation of tools, spares, etc.(00.05 t/yr)	= 0.43 "

8 1/2 yrs absorption of seawater (@ 0.02 t/yr)	= 0.17 tonnes
S.W. saturation while capsized	= 0.15 "
Pumps & piping etc., for 3 holds system	= 0.10 "
Power block & hydraulics	= 0.26 "
Estimated 'known' weights increase:	= 3.40 "

There is a natural tendency for all vessels to gain weight as they age because of the accumulation of personal gear, tools, spares and new equipment, etc.

The remaining unaccounted-for 1.66 tonnes, may be attributed to accumulated increases in the navigation and other equipment, as well as rigging, gear and mast staying, etc., due to the heavier main boom.

(e) When the after hold of the "MISS JOYE" was filled with seawater and the catch from the "ISLAND JOYE", the total weight and disposition of cargo now on board increased the mean draught and after trim of the vessel. In this loaded condition, the vessel's transverse stability characteristics were substantially below the minimum requirements of STAB 4, and her minimum freeboard was only 9.5 cm (3 3/4"). It is apparent that even in calm seas, the most moderate roll of only 2.25° would have immersed the deck edge, causing water to be shipped on the main deck. As the freeing ports in the port and starboard bulwarks became submerged at the end of each roll, their effectiveness was impaired and the shipped water was not always cleared off the deck. Prior to the capsize, water was seen to remain accumulated at the after end of the main deck, some of which found its way into the lazaret by way of uncaulked openings in the wooden deck in way of the deck penetration fittings of the air pipes leading to the fresh water and redundant oil fuel tanks in that compartment. Reportedly, shortly before the capsize, the lazaret was pumped dry, but the water on deck remained. The weight and free surface effect of the shipped water caused a further reduction of the vessel's freeboard and already poor transverse stability characteristics, such that they were then markedly below the comparison minimum standards.

It would appear that while in this highly vulnerable state, the dynamic effects produced by the motion induced by the prevailing sea conditions overcame the vessel's initial ability to recover. Having been rolled toward the limiting range of positive stability, the "MISS JOYE", because of the increased immersion of her

deck edge and reduced righting levers, tended to remain heeled over for some time. The reported pumping overboard of catch preservation water from the after and forward starboard side fish holds, in an attempt to right the vessel, created additional free surface effects in these holds which led to a further reduction in transverse stability and retarded the vessel's recovery.

When the "MISS JOYE" remained heeled over to starboard, seawater would have entered the deck-house through the closed but immersed weathertight deck-house door and window frames which, in conjunction with the renewed flooding of the lazaret and fresh water tank through the immersed uncaulked deck penetration fittings and air pipes, prevented the vessel's return to the upright.

(f) In general, few fishermen fully understand free surface effect and fewer appreciate the substantial loss of transverse stability when water, even a few inches, is shipped and retained on deck. Coupled with the loss of effective waterplane area when the deck edge is submerged, the effects can be disastrous. Furthermore, some critical wave heights and frequencies, in conjunction with a particular vessel's length, hull form, motion, attitude and speed, can cause a dramatic loss of waterplane area, and hence stability. If the "MISS JOYE" encountered such a situation, then the impetus caused by such a sudden reduction or fluctuation could have overcome her already low dynamic stability characteristics, and initiated the heeling from which she did not recover.

In simple terms: because of the total deadweight loaded in three holds, the subsequent low freeboard, the free surface effect of the water shipped and retained on the main deck, and possible encounter with a critical wave formation, the "MISS JOYE" did not have sufficient transverse stability to withstand the dynamic heeling forces imposed upon her in the prevailing conditions. The further reduction of her transverse stability by the free surface effects, created when the fish holds were partially pumped out, slowed down the vessel's rate of recovery and allowed more time for the downflooding of the deck-house and lazaret to take effect. The downflooding then continued until the vessel's positive transverse stability was completely lost and the "MISS JOYE" capsized.

6. **Weather**

The marine forecast for Queen Charlotte Sound issued by Environment Canada at 1745, July 24, 1986 and valid until 1800, July 25 was as follows:

> Winds west to north-west 10 to 20 knots except north-west 25 near the mainland coast early this evening. Winds becoming north-west 15 to 25 overnight. Periods of rain, drizzle or fog overnight with visibilities falling below 2 miles at times.
>
> Outlook, moderate to strong north-westerly winds.

The weather reported by the local light station on Egg Island, some 7 cables from the position of capsizing, at 2000, July 24, 1986 was as follows:

> Partly cloudy with:
>
> | | |
> |---|---|
> | Wind | North-west at 20 knots |
> | Seas | Moderate with 3 ft. chop |
> | Swell | Low/moderate north-westerly |
> | Visibility | 12 nautical miles |

7. **VHF Requirement**

Vessels of less than 300 gross tons are not required by the Ship Station Radio Regulations to carry a radio. However, if transmitting equipment is fitted it must comply with the applicable Regulations.

8. **Radio Operator's Certificate Requirements**

The General Radio Regulations, Part II, made pursuant to the 'Radio Act' state in part:

> 78. The apparatus of all radio stations shall be worked only by operators holding a Canadian certificate of proficiency...
>
> 88. The holder of a Restricted Radiotelephone Operator's Certificate (Maritime) may act as a radiotelephone operator on a ship station.

The operator aboard the "MISS JOYE" did not hold a Restricted Radiotelephone Operator's Certificate

(RROC) (Maritime).

A Department of Communications publication titled 'Guide to Marine Radiotelephone Operation', states in part:

> To obtain an RROC, an examination in radiotelephone operating procedures and regulations is conducted by the Departmental Radio Inspectors. Upon satisfactory completion of the examination the RROC is issued to the candidate and is valid for the lifetime of the holder (it is not renewed or updated). There is presently no fee for the exam or certificate.

9. Distress and Calling Frequency

A number of publications, including the 'Radiotelephone Operator's Handbook-Land/Sea/Air'; the 'Manual of Safety and Health for Fishermen'; Radio Aids to Marine Navigation'; 'Guide to Inspection Regulations for Small Fishing Vessels' and 'Safe Boating Guide', all stipulate that VHF Channel 16 is a designated distress and calling frequency and that this channel is monitored by all shore stations and ships at sea on a 24-hour basis.

No 'MAYDAY' message was transmitted from the "MISS JOYE" on channel 16 and the operator received no response to his distress call on channel 78A.

10. Survival/Distress Equipment

The vessel complied with the Small Fishing Vessel Inspection Regulations; the performance of the equipment was as follows:

Lifejackets: The crew wore approved lifejackets but they did not enter the water as they used the liferaft.

Liferaft: The 6 person Beaufort inflatable liferaft with "A" packs, was stowed on the port side of the flying bridge. The liferaft was launched over the vessel's port side and inflated in a conventional manner by pulling the painter cord; the raft inflated in a proper manner. Six persons boarded by walking along the port side of the heavily listed vessel and stepping into the liferaft.

EPIRB: None required by regulation and none were fitted.

Immersion Suit: None required by regulation and none were carried on board

Lifeboat: The 4.57 m aluminum seine skiff approved for use as a lifeboat was secured athwartships at the stern; it became swamped and was not launched.

R/T: The vessel had 2 R/T's (see equipment list). The 'MAYDAY' was not transmitted on Channel 16.

11. Certification and Experience of Crew

(a) The skipper of the "MISS JOYE" does not hold a Certificate of Competency from the Department of Transport nor was he obliged to hold such a certificate to operate the vessel.

Aged 24 years, he has served on fishing vessels since his youth and has sailed as skipper for approximately 6 years. He was on his second trip aboard the "MISS JOYE".

(b) The engineer on the "MISS JOYE" does not hold a Certificate of Competency nor is he required to do so. He has served on board fishing vessels since 1979, was on his second trip aboard the "MISS JOYE" and was starting his second year as an engineer.

(c) Of the remaining crew members, one deck-hand had fished with the same company for 7 years, another had fished for 5 years of which 4 years were with the same company. The cook and the guest were both inexperienced seafarers.

Findings

The "MISS JOYE" capsized in moderate weather conditions off Egg Island as a result of having insufficient transverse stability to withstand the dynamic heeling forces imposed upon her. It would appear that the following factors contributed to the loss of transverse stability until the vessel capsized:

- an excessive load of fish and catch preservation water which increased the vessel's mean draught and after trim beyond her usual loaded figures;

- the lazaret downflooded due to lack of caulking around two air pipe deck penetrations, which further increased the vessel's mean draught and after trim;

- ropes which obstructed the bilge suction, such that the lazaret could not be satisfactorily pumped out;

- the freeboard of only 9.5 cm (3 3/4") which allowed the shipping of water on deck at very small angles of heel, further increasing the vessel's mean draught and after trim;

- the free surface effect of the water shipped on deck and in the lazaret which was compounded by the subsequent pumping of the fish holds;

- the progressive reduction of transverse stability which slowed down her rate of recovery allowing more time for downflooding to continue until all positive transverse stability was lost.

Other Findings

The radiotelephone distress message was not transmitted on a distress frequency.

Part II

Note: All times in Part II are expressed in Pacific Standard Time (UTC munus 8 hours).

Narrative

The "MISS JOYE" departed from Campbell River, B.C., November 27, 1986 and participated in the last salmon fishery opening of the 1986 season from November 27 to November 28 in regulatory area '14', off Qualicum Beach.

At the end of this open period, the crew of the "MISS JOYE" sold and transferred their catch of approximately 1400 head of salmon to a fish packer off French Creek and returned to Campbell River at 2130, November 28. During the return voyage, the fish holds were cleaned and hosed and the bilges were pumped dry.

The "MISS JOYE" remained in Campbell River from November 28 until December 7, 1986 during which time some general maintenance was carried out on the vessel but no crew members

lived on board.

At 1100, December 7, the skipper rejoined the "MISS JOYE" to take the vessel for winter lay-up at Port Hardy, some 108 miles distant through sheltered waterways. A close relative, who was also an experienced fisherman and an engineer, came along with the skipper to assist as deck-hand for the short voyage. A non-seafaring guest of the skipper also boarded the vessel for the scenic trip to Port Hardy.

When ready for her passage, the "MISS JOYE" had her seine net wound on the seine drum and her six man aluminum skiff stowed at the stern with its bow resting on the drum. The main boom was in the raised working position and was stayed tight; the hatchway to the fish holds was covered with hatch-boards but was not tarped and battened down. All manholes on deck were closed and secured.

The "MISS JOYE"s engine-room fuel oil tanks were approximately 76% full, each containing 2,870 litres (638 gallons), not having been topped-up since her last voyage, and the fresh water tank was almost dry. There was no cargo on board and the draught was later determined to have been 2.42 m forward, 2.83 m aft.

With all equipment working satisfactorily, the skipper checked the Tide Tables for Seymour Narrows and the "MISS JOYE" departed from Campbell River at approximately 1200, December 7, 1986, her departure having been delayed somewhat by another vessel secured on her outboard side.

Once clear of the public harbour breakwater, the "MISS JOYE" was headed in a northbound direction through Discovery Passage and the automatic pilot was engaged. The engine was set at 1,900 rpm to give a full sea speed of approximately 9.5 knots in the lightly loaded condition. The skipper then left the deck-hand in charge of the wheel-house while he proceeded to the engine-room and pumped out the engine-room and lazaret bilges; the fish hold bilges were checked prior to sailing and found to be dry.

Just beyond the Campbell River harbour limit, the skipper returned to the wheel-house and assumed the conduct of the vessel and the deck-hand left to attend to duties on deck and in the galley.

When the "MISS JOYE" was in a position approximately 2.5 cables south of Maud Island South Light, the skipper shifted his command position to the flying bridge and changed over to hand steering using the wheel. He was accompanied on the flying bridge by the deck-hand; navigation was by local

knowledge as the vessel made her approach to Seymour Narrows and no positions were being plotted on the chart.

The skipper's guest was located in the galley/pantry area at this time and the door to the after deck was open.

The "MISS JOYE" approached Maud Island on a course of approximately 285°T and when in a position estimated to be 3.1 cables south by west of Maud Island Light, (LL No.516), an alteration of course was made to approximately 350°T to keep the vessel to the starboard side of Seymour Narrows. At this time the "MISS JOYE" was feeling the effects of the ebb stream and her engine speed was reduced to approximately 1,100 rpm.

Weather conditions existing at the time were reported to be partly cloudy with:

Wind	Light airs
Visibility	8 miles
Sea	Calm, tide rips and other effects of the current in the general area
Air Temperature	7°C

The state of the tide in the vicinity of Seymour Narrows was approximately one hour before low water and about the time of maximum current velocity, which was predicted to be 10.2 knots in a northerly direction.

The "MISS JOYE" passed approximately 1.1 cables off Maud Island and speeds were adjusted as necessary to maintain effective steerage.

As the "MISS JOYE" passed Maud Island Light, she was strongly affected by the current which caused her to roll to port and her skiff to move from its stowed position. The skiff, which had its bow line passed over the drum and secured on the port side, was no longer visible from the flying bridge and fearing that it had been lost overboard, the skipper passed the conduct of the vessel to the deck-hand whilst he proceeded aft to investigate. The skiff, still secured, was found to have slid from the drum until it was not visible from forward.

On returning to the flying bridge, the skipper left the deck-hand in charge of the piloting whilst he observed the navigation from close by.

As the "MISS JOYE" approached North Bluff she expe-

rienced whirlpools, back-eddies, and other tidal effects in accordance with the state of the tide.

When in a position approximately 1.1 cables south-west of North Bluff and whilst attempting to make good a course of about 350°T, the "MISS JOYE" began to set to the north-east towards North Bluff. To avoid coming too close to the shore, the engine revolutions were reduced to an idling speed; however, after this action, the vessel's bow swung sharply to starboard. Speed was immediately increased to two-thirds ahead and the wheel turned hard-a-port to try to counteract tne swing. This manoeuvre reduced the rate of swing and the vessel was almost steady when the bow was apparently influenced by a counter-current, and the "MISS JOYE" started to swing uncontrollably to starboard, heeling over at the same time.

Engine revolutions were again reduced to an idling speed in an attempt to regain control of the vessel, however, at approximately 1300, in estimated position 50°08.5'N, 125°21.1'W, the "MISS JOYE" continued to list quickly to starboard until her bulwarks were submerged.

With no time, to broadcast a 'MAYDAY', the skipper made his way down the flying bridge ladder and assisted his guest to climb out of the galley door and along the vessel's port side to about amidships where they joined the deck-hand who had climbed over the flying bridge dodger and made his way down the port side of the heavily listed vessel. On the skipper's orders, the deck-hand reached in through the wheel-house door and stopped the engine by hitting the engine stop button on the wheel-house console.

With the vessel lying on her beam ends, the skipper again managed to open the wheel-house door and retrieve three lifejackets and a spare unconnected VHF radiotelephone. He attempted to utilize this VHF by connecting it on the flying bridge but without success, as the vessel had lost all power.

At this time, flood water was entering through the windows and doors and slowly downflooding throughout the vessel until she eventually lay completely capsized with her keel just above the water. The survivors clung onto the overturned hull as the "MISS JOYE" continued to drift northwards, being carried by the current.

The "MISS JOYE"s progress through Seymour Narrows had been observed by two local citizens from their home in the Menzies Bay area and immediately the vessel capsized, they reported the incident to the Courtenay detachment of the Royal Canadian Mounted Police (RCMP), who in turn reported to

Rescue Coordination Centre (RCC) Victoria at 1300, December 7, 1986.

RCC Victoria issued a 'MAYDAY' relay broadcast through Comox Coast Guard Radio Station (CGRS) at 1303 and tasked the Canadian Coast Guard cutter (CCGC) "POINT RACE" which departed from Thurston Bay at 1310. RCC Victoria, also tasked the 442 Transport and Rescue Squadron based at CFB Comox, at 1307 to assist as necessary and the RCMP vessel "RIVET CARNAC" was dispatched to the scene at 1315.

The American vessel "KRYSTAL STAR" which was southbound through Seymour Narrows and the Quadra Island ferryboat "QUADRA QUEEN 2" responded to the 'MAYDAY' relay broadcast and were tasked by RCC Victoria. The small fishing vessel "RIVERS INLET" which was northbound through Seymour Narrows was the first to arrive on scene at 1324 and rescued all three survivors safely from the hull of the "MISS JOYE".

The "MISS JOYE" had drifted in close to the shore in position 50°08.8'N, 125°20.9'W about 0.5 mile north of North Bluff and with the assistance of crew members from the "RIVERS INLET", the "MISS JOYE" was secured at 1325 to a tree on the shore.

The 'MAYDAY' relay was cancelled at 1337.

The survivors were then transferred to the southbound "KRYSTAL STAR" at 1339 and to the CCGC "POINT RACE" at 1424, which transported them to Campbell River, arriving there at 1459; none required medical attention.

The "MISS JOYE" was later towed, in the capsized condition, to Plumper Bay where she was righted on December 8, 1986 and then towed to a marina in Brown's Bay across Discovery Passage. Later, that same evening the vessel was towed to French Creek to undergo repairs, arriving there on the morning of December 9.

Analysis

1. Access Hatches

Manholes to the lazaret space and to the fish tanks were flush with the deck and were of aluminum alloy construction with a crossbar locking device, key operated on the outside; all were secured at the time of the casualty.

Main Cargo Hatch

The main hatch was covered with unsecured wooden hatch

boards and was not tarped and battened down. The three fish holds are serviced by the one main hatchway.

2. Weather

The marine forecast for Queen Charlotte Strait, Johnstone Strait, issued by Environment Canada at 1045 December 7, 1986 and valid until 1100, December 8, was as follows:

> Winds variable 5 to 15 knots rising to east to south-east 10 to 20 Monday morning. Mostly cloudy, clearing overnight.
> Outlook- moderate to strong east to south-east winds.

The weather reported by local light stations at 1300, December 7, 1986 was as follows:

Chatham Pt.	Overcast, visibility 15 miles, no wind and rippled sea.
Cape Mudge	Overcast, visibility 6 miles, wind NW 6 knots, and rippled sea

3. Tides and Currents

Tidal differences for Seymour Narrows are referenced on Owen Bay and given in the Canadian Tide and Current Tables, Volume 6, as are Current Tables for Seymour Narrows.

On December 7, 1986, high water at Seymour Narrows was predicted to be at 0904 with a height of 4.4 metres above chart datum and low water was predicted to be at 1353 with a height of 3.1 metres above chart datum. Slack water was predicted to be at 0945 and the time of maximum current velocity on the ebb tide flowing in a northerly direction, was predicted to be at 1300 with a rate of 10.2 knots.

The effects of the ebb current causes a counter-current in the small bay (known locally as Verdes Bay) south of North Bluff which in turn causes tide rips, back-eddies, whirlpools and other tidal phenomena in the general area.

Between Cape Scott and Campbell River, the passage separating Vancouver Island from the mainland is narrow

and strewn with islands. This, and the fact that it takes the tide from the south two hours longer to reach the narrowest parts of the channel than the tide from the north, explains the extremely rapid tidal streams associated with Seymour Rapids. This difference results in a two hour lag in the time of the tides at Campbell River compared to Seymour Narrows.

4. **Cautionary Note**

The thirteenth edition of the Sailing Directions for the British Columbia Coast (South Portion) states, in chapter 7, paragraphs 119 and 120:

> 119 **Caution** - Mariners are advised to navigate Seymour Narrows only at or near slack water if their vessel is of low power, towing other vessels, or is a small vessel, under about 65 feet (20 m) long. Fatal accidents have occurred when small vessels have attempted to navigate this narrows when the tidal stream is running at full strength.
>
> 120 Small vessels have capsized with loss of life while navigating Seymour Narrows even near slack water and in reasonable weather conditions: they were in light condition with considerable top weight. Precautions should be taken to maintain adequate stability and trim even when planning to transit at slack water. All crew members should be alert and ready to cope with any emergency situation.

The "MISS JOYE" carried the latest edition of charts and Tide Tables for her intended route, however, she did not have the thirteenth edition of the Sailing Directions for the British Columbia Coast (South Portion) on board nor is she required by regulation to carry the publication.

The Charts and Publications Regulations, made pursuant to the Canada Shipping Act, require all self-propelled ships other than ships of war, to carry amongst other publications, a copy of the Sailing Directions; however, Part 1, paragraph 2, of the Regulations states in part:

(2) This part does not apply to a ship that is of less than 100 tons, gross tonnage,

if the person in charge of the navigation of that ship

(a) is informed of the location and character of charted

(i) shipping routes,
(ii) lights, buoys and marks, and
(iii)navigational hazards, and

(b) has a general knowledge of the prevailing navigational conditions in the area in which the ship is to be navigated.

It was reported by observers on shore in the Menzies Bay area that from their vantage point, the "MISS JOYE" appeared to be navigating very close to shore and actually entered the mouth of Verdes Bay before heading north towards North Bluff.

The skipper of the "MISS JOYE" had passed through Seymour Narrows numerous times over the past six years and approximately twelve times, as skipper of the "MISS JOYE", during 1986. The deck-hand had also passed through Seymour Narrows numerous times during his long seagoing career as a fisherman. Both were aware of the dangers involved in passing through Seymour Narrows with a fast flowing current and reported that the normal procedure was to attempt to transit the Narrows at a more favourable state of the tide; however, a passage would not normally be cancelled for the prevailing conditions experienced on December 7. In this instance, the vessel's departure was delayed due to another vessel being secured on her outboard side.

Neither the skipper nor the deck-hand were familiar with the Sailing Directions publication.

5. **Mechanical Equipment**

It was reported that both the engine and steering gear were operating in a satisfactory manner throughout. The problem experienced in steering the vessel was a result of the effects of the fast flowing current and not a mechanical malfunction.

When the vessel was righted, all engine control levers were found to be in the neutral position.

6. Stability

(a) The loading conditions compiled as part of the post-casualty stability analysis of the "MISS JOYE", incorporate the distribution of fishing gear, oil fuel, fresh water and other consumables reportedly on board at the time of the capsize. These loading conditions are based upon the tanks, hydrostatic and righting lever curves (KN), and basic data included in the vessel's original Trim and Stability Booklet approved June 6, 1978 together with the current lightship weight and characteristics verified from the inclining experiment carried out on November 6, 1986.

(b) The reported disposition of weights on board the vessel at the time of the capsize are listed as follows:

Oil fuel (75%)*	4.80	tonnes	Engine-room tanks (P&S)
Fresh water (10%)*	0.25	"	F.W.Tank Aft (S)
Fresh water	0.05	"	Residue, O.F.tank aft(P)
Misc.fishing equip.	0.15	"	On main deck
Provisions, etc.	0.15	"	In galley & stores
Crew & effects (3)	0.30	"	In accommodation
Seine net & gear	5.00	"	Wound on drum
Seine skiff (alloy)	0.27	"	Partly resting on drum
Summer bunt (net)	0.09	"	In after fish hold

Fixed Weight added after November 6, 1986

Awning	0.08	"	On flying bridge
Instrument locker	0.12	"	On flying bridge

* Approximate

The main cargo boom was topped to about 65° and secured on the vessel's centre line.

These items are the 'reported best estimate' of the distribution of the deadweight on board the vessel shortly before she capsized.

(d) The vessel's current lightship weight and characteristics as verified from the inclining experiment carried out November 6, 1986, during the casualty investigation process, showed that since the approved Trim and Stability Booklet was prepared in 1978, the vessel's lightship characteristics have changed; the current and original details are listed for comparison:

Inclined	Lightship Wt	VCG	LCG
Feb.20,1978	46.10 tonnes	2.73 m(8.94')	9.22 m(30.24')
Nov. 6,1986	50.89 "	2.89 m(9.49')	9.32 m(30.59')

As the 1978 lightship weight included a seine skiff of 0.27 tonnes, direct comparison shows an actual increase of 5.07 tonnes which can be generally accounted for by 'known' changes and estimated normal weight accumulation during the previous 8 1/2 years service.

(d) The post-casualty stability analysis of this third capsize focused upon the detrimental effects of the vessel's transverse stability characteristics brought about by the location of the seine net and skiff above the main deck and the relatively light below-deck dead-weight. The analysis shows that the "MISS JOYE"s transverse stability characteristics were substantially below the minimum standards of STAB 4. on her departure from Campbell River.

(e) It would appear that while proceeding through Seymour Narrows, the "MISS JOYE" encountered a strong underwater eddy and other effects of the confused and fast flowing tidal current, causing her to roll to starboard. The heeling effect, produced by the impetus of the suddenly induced roll, overcame the vessel's initially low transverse stability and the continued action of the current caused the angle of heel to increase. Because of her inherently low righting levers, the vessel continued heeling and at approximately 17° the deck edge became immersed. Because of the reduction of effective water-plane and the effect of water shipped through the immersed freeing ports, the angle of heel continued to increase and, as can be seen from the attached Figure No.1, the maximum righting lever occurred at 23°. At 27.5° heel the bulwark top rail became immersed after which the increased quantity of water being shipped accelerated the heeling motion and, combined with the effects of the fast flowing current, prevented the vessel from returning to the upright. The "MISS JOYE" did not have sufficient transverse stability to withstand these dynamic heeling forces imposed on her in the prevailing conditions.

When the "MISS JOYE" remained heeled over to starboard, downflooding took place into the deck-house through the immersed open doorway and window frames and into the fish holds through the unsecured hatchway until the vessel's positive stability was completely lost and the "MISS JOYE" capsized.

(f) The post-casualty analysis also showed how the vessel's transverse stability could have been improved had the seine net been stowed below in the after hold and the skiff secured flat on the afterdeck. Comparison of the vessel's actual and 'achievable' levels of transverse stability is graphically illustrated in Figure No.1, which shows that the vessel's ability to resist the capsizing forces encountered in Seymour Narrows could have been more than doubled by taking these precautions and it is highly likely that this increase would have been sufficient to prevent the capsizing.

(g) The practice of sending-down and securing unnecessary topweight prior to sailing or in anticipation of adverse sea or weather conditions is an accepted part of good seamanship, and is recommended by insurers and by regulatory and fisheries advisory bodies. Numerous publications and fishermen's manuals - some with particular reference to vessels engaged in seining operations, advise that heavy fishing gear not in use should be secured and stowed as low as possible within the vessel.

7. Engine-room Pumps

The vessel was equipped with the following pumps:

Fire/Bilge Pump	15 litres per second, 51 mm diameter pump, driven by a hydraulic power take-off on the main engine, capable of drawing from all watertight spaces i.e., lazaret, engine-room, all fish hold compartments and accommodation.
Bilge Pump	15 litres per second, 31 mm diameter Monarch pump, hydraulically driven by hydraulic power from the power take-off on the main engine.
Auxiliary Pump	A Pump and Power 51 mm diameter hydraulic pump, with hand operating capabilities, located on deck and for fish hold use.

There was insufficient time to utilize the pumps.

8. Survival/Distress Equipment

The vessel complied with the Small Fishing Vessel Inspection Regulations; the performance of the equipment

was as follows:

Lifejackets:	The crew donned approved lifejackets which were retrieved with some difficulty from the partially flooded wheel-house, but did not enter the water as they remained on the overturned hull until rescued.
Liferaft:	The 6 person Beaufort inflatable liferaft with "A" packs was stowed on the port side of the flying bridge. There was no time to release the liferaft and it was not fitted with a hydrostatic release.
EPIRB:	None required by regulation and none were fitted.
Immersion suits:	None required by regulation and none were carried on board.
Lifeboat:	The 4.6 m (15') aluminum seine skiff, approved for use as a lifeboat, was secured at the stern. There was no time to launch the skiff prior to capsizing.
R/T:	The vessel had 2 R/T's. There was insufficient time to broadcast a 'MAYDAY' message. An attempt was made to use the 'spare' VHF from the flying bridge but without success.

9. Damage

Damage sustained by the "MISS JOYE" was mainly water related.

The engine was serviced by a mechanic on arrival at the Brown's Bay marina and was found to be functioning satisfactorily, this being attributed to shutting the engine off before flood water entered the system.

10. Certification and Experience of Crew

(a) The skipper of the "MISS JOYE" does not hold a Certificate of Competency from the Department of Transport, nor was he obliged to hold such a certificate to operate the vessel.

During the investigation of the July 1986 incident, the skipper had been advised of the requirements of the Radio Act with regard to the Restricted Radiotelephone Operators Certificate (Maritime). However, this certificate had not been obtained by the skipper during the period from the July incident until the time of the December 7 incident. It was apparently obtained subsequent to this latest incident as the result of an inspection of the radio equipment on board the vessel, conducted by the Department of Communications.

Aged 24 years, the skipper has served on fishing vessels since his youth and as a skipper for approximately six years; he sailed as skipper aboard the "MISS JOYE" during the 1986 season.

(b) The deck-hand on the "MISS JOYE" did not hold a Certificate of Competency from the Department of Transport nor was he obliged to hold such a certificate.

He has served as a deck-hand and engineer/deck-hand on fishing vessels for the past thirty years. He joined the "MISS JOYE" only to assist in the short voyage to Port Hardy.

Findings

The "MISS JOYE" capsized in Seymour Narrows, B.C., in good weather conditions at about the time of maximum current velocity on the ebb tide, as a result of having insufficient transverse stability to withstand the dynamic heeling forces imposed upon her.

It would appear that the following factors contributed to the loss of transverse stability until the vessel capsized:

- the vessel sailed from Campbell River with the seine net wound around the seine drum and the skiff rested with its bow on the drum whilst the below-deck deadweight was relatively light, causing a preponderance of top weight, and

- the sudden induced roll caused by an underwater eddy, followed by the continued effects of the fast flowing tidal current, which led to the shipping of water on deck, downflooding, and eventual loss of her relatively low transverse stability.

Other Findings

It was imprudent to attempt to navigate the "MISS JOYE" through Seymour Narrows with the tidal stream running close to full strength.

This is the third time that this vessel has capsized and the second time when in virtually the same position and from similar causes.

The action by concerned citizens in reporting the incident and the subsequent response by mariners and successful rescue of survivors is commendable.

Part III

General Analysis

1. **Construction and History of Vessel**

The f/v "MISS JOYE" was built in 1971/2 and, upon completion, was issued with the required Steamship Inspection Certificate. She was originally used as a fishpacker and salmon and herring seiner until 1978 after which time she was used primarily as a salmon seiner and occasionally as a packer.

The vessel has accommodation in the forecastle head for 4 crew members. The entrance to this area is by a stairway situated on the starboard side of the wheel-house with an emergency exit through an escape hatch to the foredeck.

The remaining accommodation and galley/pantry areas are located immediately abaft the wheel-house with exits via the port wheel-house door, starboard accommodation door and at the after end of the galley/pantry area.

The hull is subdivided by four transverse bulkheads of which three enclose and subdivide the fish hold compartments. These three bulkheads are watertight whereas the bulkhead between the engine-room and accommodation area is not.

Fuel oil is carried in tanks, each with a capacity of approximately 3,755 litres. They are located on the port and starboard sides of the engine-room. A third fuel tank, with a capacity of 2,630 litres, is located on the port side of the lazaret space. This tank however, is very seldom used.

The fresh water tank is located on the starboard side of the lazaret space and has a capacity of 2,494 litres.

Following the initial capsizing of the vessel in 1977, the vessel was salvaged and re-fitted. An inclining experiment was subsequently performed, at which time, 2.48 tonnes of permanent ballast was installed in the bilges of the engine-room and fish hold. A survey by the Ship Safety Branch of the Canadian Coast Guard was conducted June 6, 1978 at which time, her stability booklet was approved. A quadrennial survey was conducted at New Westminster, B.C., by the Ship Safety Branch of the Canadian Coast Guard June 6, 1982 and nothing untoward was observed.

During the early part of 1986, the vessel dry-docked at Shelter Island Marina, Richmond, B.C., and was fitted with a new keel. She underwent an external hull inspection by the Ship Safety Branch of the Canadian Coast Guard June 12, 1986.

Later that same month, the vessel was at Surrey, B.C., where her fish hold was subdivided into port and starboard forward holds and one after hold compartment. The balance of the hull and machinery survey was conducted at Port Hardy, B.C., July 9, 1986.

Following the second capsizing in July 1986, the vessel was salvaged, repaired and re-entered into service as a salmon seiner, August 31. Between that date and November 28, 1986 she participated in five salmon fishery open periods and was subjected to an inclining experiment November 6, 1986.

2. Stability Evaluation

(a) Capsize No. 1

Approval of Stability data of small fishing vessels was not required prior to July 6, 1977 and, after that date, the regulatory requirements were only applicable to vessels engaged in fishing for herring or capelin.

Although the regulations did not apply to the "MISS JOYE", the vessel was inclined in February 1978, following the capsizing incident of 1977. The owner submitted the stability data obtained from the inclining experiment to the Ship Safety Branch of the Canadian Coast Guard in order that an assessment could be made for her future safe operation. The resulting approved Trim and Stability Booklet incorporated loading

conditions for herring packing operations only. The weight of a net stowed on the seining drum was not included in the data.

(b) Capsize No. 2

At the time of the second capsizing incident, the "MISS JOYE" was engaged in salmon seining operations. She had a net weighing approximately 4,500 kg stowed on the seining drum in addition to a load of fish such that she retained only 9.5 cm freeboard.

An inspection of the salvaged vessel revealed that a number of modifications and additions had been made since the trim and stability data was approved which, collectively, resulted in an apparent increase of approximately 5.0 tonnes to the lightship weight as established in 1978.

The vessel's original single hold of 44.32 cubic metres (1,565 cubic feet) capacity had been subdivided by permanent insulated bulkheads into three independent holds of approximately equal volume. The current layout being such that the ship's centre-line, which also extends into the main hatchway up to the top of the coaming, while the after hold has no permanent centre-line bulkhead or channels into which portable shifting boards could be fitted. A subsequent rolling period test indicated a marked reduction of metacentric height (GM). Consequently, a detailed examination was carried out during the vessel's refit both afloat and while hauled out, from which it was established that the current principal dimensions, hull form, bulkheads and tank locations and capacities, etc., conformed with the details and basic data included in the original Trim and Stability Booklet and hull lines plan.

With the owner's co-operation, an inclining experiment was carried out at Campbell River, B.C., November 6, 1986, and the vessel's current lightship characteristics positively verified.

A post-casualty stability analysis of the "MISS JOYE" focused upon the detrimental effects on her transverse stability characteristics brought about by the loading and subsequent low freeboard, together with the free surface effect of seawater reportedly shipped on the main deck, prior to the capsize. Copies of the detailed calculations are available upon request.

When compiling the loading and stability conditions, due

allowance was made for the free surface effect of loose liquids in the partially filled oil fuel and fresh water tanks, and also for the 'slack' surface of the catch preservation water in the hatch coamings of the reportedly 'pressed-up' fish holds. No such allowance was made for the seawater entering the lazaret through the uncaulked deck penetration fittings which remained immersed after pumping of that compartment was discontinued. Consequently, it is considered that the vessel's transverse stability characteristics at the time of the capsize were, in fact, worse than the calculated figures indicate.

Loading conditions complied as part of the post-casualty analysis illustrate how the initially low transverse stability characteristics were drastically reduced by the free surface effects of the seawater shipped on the main deck, and then progressively eroded by the 'slack' surfaces created in the fish holds when these compartments were partially pumped out.

The reported deadweight and loading details show that prior to the casualty, the "MISS JOYE" was heavily loaded, trimmed by the stern, and retained only 9.5 cm (3/4") freeboard. At this time her transverse stability characteristics were significantly lower than the minimum accepted standards of STAB 4, and the most moderate rolling of only 2.25° would cause the main deck edge to become immersed. Because the effectiveness of the freeing ports in the port and starboard bulwarks was impaired as they became immersed at the end of each roll, the shipped water was not always cleared off the deck, and reportedly, shortly before the capsizing, was seen to have accumulated toward the after end of the main deck.

The weight and free surface effect of the shipped water retained on deck caused further deterioration of the vessel's freeboard to only 7.6 cm (3"), and a drastic reduction in transverse stability, such that the maximum righting lever (GZ) of 0.064 m (0.21 ft) was reached at 15° heel, the total area under the GZ curve was 0.022 mR (4.06 ft°) and the range of positive stability was only 29°.

These maximum figures are markedly below the minimum criteria of STAB 4, in that the total dynamic stability of 0.022 mR (4.06 ft°) reached at 29° heel, is only 24% of the minimum requirement for angles of heel up to and exceeding 40°. Furthermore, the maximum righting lever (GZ) was only 0.064 m (0.21 ft) at 15° heel, while the

minimum requirements indicate that a GZ of 0.20 m (0.67 ft) is to be reached at an angle of heel of not less than 30°, and that the maximum righting lever should be reached at not less than 25°. These transverse stability characteristics are based upon the 'ideal' static sea state. In actual sea conditions, angles of roll are usually greater than those calculated by static methods, and therefore in service, the reserve dynamic stability of small vessels is subject to considerable fluctuation.

Synopsis

It would appear that while the "MISS JOYE" was in the highly vulnerable state indicated by the above characteristics, the dynamic heeling effects produced by the vessel's motion in the prevailing conditions overcame her initial ability to recover. Having been rolled toward the limiting range of positive stability, the vessel, because of the immersed deck edge and reduced righting levers, tended to remain heeled over for some time. The reported discharge overboard of catch preservation water from the after and forward starboard side fish holds, in an attempt to right the vessel, created additional free surface effect in these holds which virtually eliminated the remaining positive transverse stability. Furthermore, the athwartship shift of the loose fish and preservation water in the partially pumped-out holds, together with the renewed flooding of the lazaret, increased the heeling moment. The heeling moment would have been further increased when the seawater entered the partially immersed deck-house and downflooded into the crew and engine-room compartments. The combined effects of the increasing heeling moments and the progressive downflooding, caused the angle of heel to increase, and the "MISS JOYE" to capsize.

During the capsizing motion, as the "MISS JOYE" heeled toward and passed 90°, the remaining unsecured boards covering the main hatchway would have been dislodged by the fish and preservation water escaping from the filled forward port side hold and after hold. The final momentum of the capsize was such that the volume of air entrapped within the partially emptied holds and forward compartments, in conjunction with the inherent buoyancy of the wooden hull structure, was sufficient to ensure that the "MISS JOYE" remained afloat after the capsize, and facilitated her later recovery.

(c) Capsize No. 3

The third incident occurred December 7, 1986, while proceeding through Seymour Narrows, B.C., when the "MISS JOYE" capsized in circumstances similar to those of her first casualty. At the time of the third capsize, the vessel was outfitted for salmon seining and carried a net which was wound onto the seining drum at the after end of the main deck. Reportedly, her holds were empty, except for a summer bunt net, the engine-room oil fuel tanks were approximately three-quarters full, and the fresh water tank was nearly empty.

A post-casualty stability analysis of this third capsize focused upon the detrimental effects on the vessel's transverse stability characteristics brought about by the relatively light below deck deadweight and the concurrent location of the seine net and skiff above the main deck. Copies of the detailed calculations are available upon request, and the principal criteria are included in this report for direct reference and comparison with the minimum values required for compliance with the Standards of STAB 4. These loading conditions incorporate the distribution of fishing gear and consumables reportedly on board at the time of the capsize, and are based upon the hydrostatic and righting lever curves and basic data included in the vessel's original Trim and Stability Booklet, together with the current lightship weight and characteristics verified from the inclining experiment carried out November 6, 1986, during the casualty investigation process.

The reported loading condition upon departure from Campbell River, B.C., shows that the transverse stability characteristics of "MISS JOYE" were substantially below the minimum standards of STAB 4.

The vessel's initial transverse stability as indicated by a metacentric height (GMf) of 0.41 m (1.342 ft), barely exceeds the minimum requirement of 0.35 m (1.15 ft), while all other criteria assessing the statical and dynamic stability characteristics fail to meet the minimum standards.

The areas under the righting lever (GZf) curve up to 30° and 40° heel of 0.042 mR (8.0 ft°) and 0.053 mR (10.05 ft°) respectively, are only 77% and 59% of the minimum requirements, while the area between 30° and 40° of 0.011 mR (2.05 ft°) is only 36% of the minimum standard. The maximum righting lever (GZf) of 0.12 m (0.40 ft), occurring at only 23°, is just 60% of the

minimum requirement, which should preferably not be reached before 30°, and never at less than 25°.

Overall assessment of the above criteria indicates that the ability of the "MISS JOYE" to resist or absorb external heeling forces, was significantly reduced because of the reduction of her transverse stability brought about by the relatively light below deck departure deadweight, and the concurrent location of the seine net and skiff above the main deck.

Post-casualty analysis also showed how the vessel's transverse stability could have been improved had the seine net been stowed below in the after hold, and the skiff secured flat on the after deck. Comparison of the vessel's actual and 'achievable' levels of transverse stability is graphically illustrated in Figure No. 1, which shows that the vessel's ability to resist the capsizing forces encountered in Seymour Narrows could have been more than doubled, and it is highly likely that this increase would have been sufficient to prevent the capsize occurring.

The 'achievable' transverse stability characteristics are such, that all of the required minimum criteria of STAB 4 are exceeded; the total dynamic stability is increased by at least 112%, and the maximum righting lever (GZf) is improved 71%. Figure No. 1 also shows that the actual range of positive stability was reached at 41.5°, before any downflooding occurred to contribute to the capsizing. The 'achievable' curve of dynamic stability shows that the onset of downflooding could have been delayed until 46.5° angle of heel, and that the external heeling effort necessary to reach this angle would have to be more than double that which the vessel actually absorbed before her positive transverse stability was lost and capsizing occurred.

Synopsis

It would appear that while proceeding through Seymour Narrows, the "MISS JOYE" encountered a strong underwater eddy in the confused and fast flowing tidal current, causing the vessel to roll to starboard. The heeling effect produced by the impetus of the suddenly induced roll, overcame the vessel's relatively low initial transverse stability, and the continued action of the disturbed waters caused the angle of heel to steadily increase. Because of her inherently low righting levers, the vessel continued heeling toward the limit of positive stability and at approximately 17°, the deck

edge became immersed. Because of the reduction of effective waterplane and the effect of water shipped through the immersed freeing ports on the starboard side of the main deck, the angle of heel continued to increase. When the heel reached approximately 27.5°, the bulwark top rail became immersed and the sudden increase in the rate and quantity of water being shipped, accelerated the heeling motion, and retarded the vessel's recovery. While in this highly vulnerable state, the vessel's heel was such, that the force of the surface current acting on the partially submerged superstructure, mast, rigging, seine net and drum, and the drag on the displaced skiff, etc., continued to the heeling moment and prevented the vessel's return to the upright. In the event, the "MISS JOYE" did not have sufficient transverse stability to withstand the dynamic heeling forces imposed on her in the prevailing conditions.

The final momentum of the capsize was such that the volume of air entrapped within the empty holds and forward compartments, in conjunction with the inherent buoyancy of her wooden hull structure, was sufficient to ensure that the "MISS JOYE" remained afloat after the capsize, facilitating both the rescue of the crew and her later recovery.

OTTAWA, ONTARIO
JUNE 1987.

Glossary

Dutch Door	A door which is horizontally divided into two sections
EPIRB	Emergency Position Indicating Radio Beacon
Free Surface Effect	Whenever there is a surface of liquid which is free to move, there is a loss of effective GM due to a virtual rise of the vessel's centre of gravity
Freeing Port	An opening in the bulwarks, sometimes with a hinged flap, to allow water shipped on deck to flow overboard
GM	(Metacentric Height) is the distance between a vessel's transverse metacentre and her vertical centre of gravity and is a measure of her ability to right herself from small angles of heel
GZ	(Righting Lever) is a measure of a vessel's ability to right herself over a range of heel angles, which, when multiplied by the vessel's displacement, indicates the righting moment
Lazaret	The enclosed space at the stern of the vessel, often housing the steering gear
LL	Light list
"MAYDAY"	International Radio Distress Signal for calling for urgent assistance

ANNEX I

CRITERIA

MARINE SAFETY BRANCH
STEAMSHIP INSPECTION SECTION
STABILITY, SUBDIVISION AND
LOAD LINE STANDARDS

The introduction which states in part:

INTRODUCTION

The standards outlined in this booklet have been developed by the Board of Steamship Inspection, Department of Transport, and indicate conditions of approval and criteria used by the approval authority in assessing submissions required by regulations written under the Canada Shipping Act.

The criteria outlined in the various standards denote minimum requirements with no maximum limits having been set. The standards are intended to supplement the regulations in matters of detail to ensure uniform minimums across the country and to give a base from which shipowners, shipbuilders, and designers may work.

The appropriate Standard in relation to this report states in part:

STANDARD: STAB 4

STABILITY STANDARDS FOR FISHING VESSELS:

(a) subject to compliance with the Large Fishing Vessel Inspection Regulations, or

(b) required to submit stability data by the Small Fishing Vessel Inspection Regulations.

OPERATING CONDITIONS WITH NO ACCUMULATED ICE

1 The following minimum intact stability criteria are to be used in the approval of stability data for the above vessels:

(i) The area under the righting lever (GZ) curve should not be less than 0.055 metre-radians up to $\phi = 30°$ angle of heel, and not less than 0.09 metre-radians up to $\phi = 40°$, or the angle or downflooding ϕ_f if this angle is less than 40°.

Additionally, the area under the righting lever (GZ) curve between the angles of heel of 30° and 40° or between 30° and ϕ_f if this angle is less than 40°, should not be less than 0.03 metre-radians.

(ii) The righting lever GZ should be at least 0.20 metres at an angle of heel equal to or greater than 30°.

(iii) The maximum righting arm should occur at an angle of heel preferably exceeding 30° but not less than 25°.

(iv) The initial metacentric height(GM),should not be less than 0.35 metres.

3 Hydrostatic and stability curves should normally be prepared on a designed trim basis. However, where the operating trim or the form and arrangement of the ship are such that change in trim has an appreciable effect on righting arms, such change of trim is to be taken into account.

7 In cases where a ship would flood through an opening, the stability curve is to be cut short at the corresponding angle of flooding and the ship is to be considered as having entirely lost her stability at that angle.

Annex 2 Regulatory requirements

The Small Fishing Vessel Inspection Regulations state in part:

PART I

FISHING VESSELS EXCEEDING 15 TONS, GROSS TONNAGE

Application

5. (1) Subject to subsections (2) and (3), this Part applies to every fishing vessel that

(*a*) exceeds 15 tons, gross tonnage, but does not exceed 150 tons, gross tonnage;

(*b*) does not exceed 24.4 m in length, and

(*c*) is not a sailing ship.

(3) Section 29 applies only to a fishing vessel of closed construction employed in catching herring or capelin where, on or after July 6, 1977,

(*a*) its keel was laid;

(*b*) it was registered as a Canadian ship;

(*c*) it was converted to herring or capelin fishing; or

(*d*) it underwent such modification that its stability characteristics were adversely affected.

Stability

29. (1) Subject to subsection (8), an inclining experiment shall be conducted in the presence of and to the satisfaction of an inspector in respect of every fishing vessel on completion or near completion of

(*a*) its construction;

(*b*) its registration as a Canadian ship,

(*c*) its conversion to herring or capelin fishing; or

(*d*) its modification as described in paragraph 5(3)(*d*)

(2) Subject to subsection (3), the results obtained from the inclining experiment referred to in subsection (1) in respect of a fishing vessel shall be developed to indicate the stability of the vessel under the following conditions.

(*a*) lightship;

(*b*) port departure;

(*c*) arrival at fishing grounds;

(*d*) half load;

(*e*) full load;

(*f*) worst operating condition affecting the stability;

A FUEL OIL CARBURANT

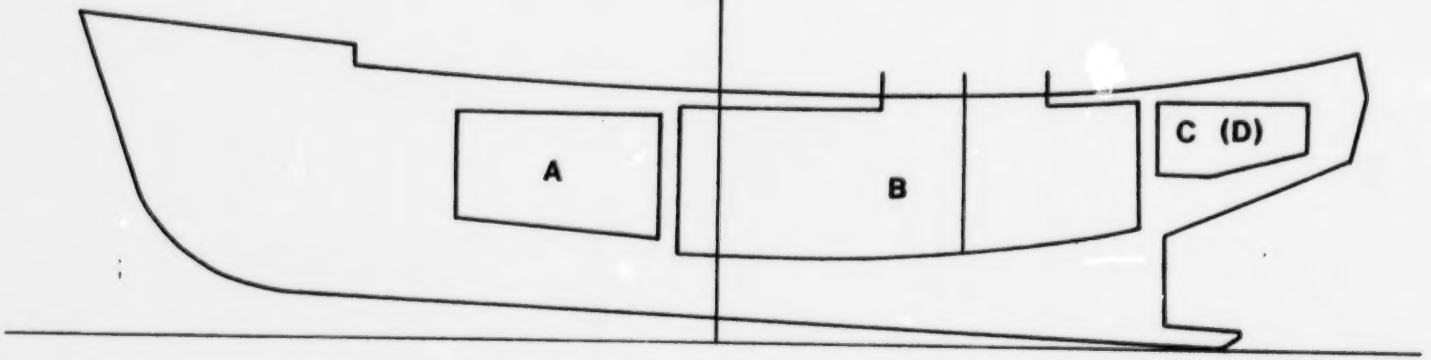
B CARGO CARGAISON

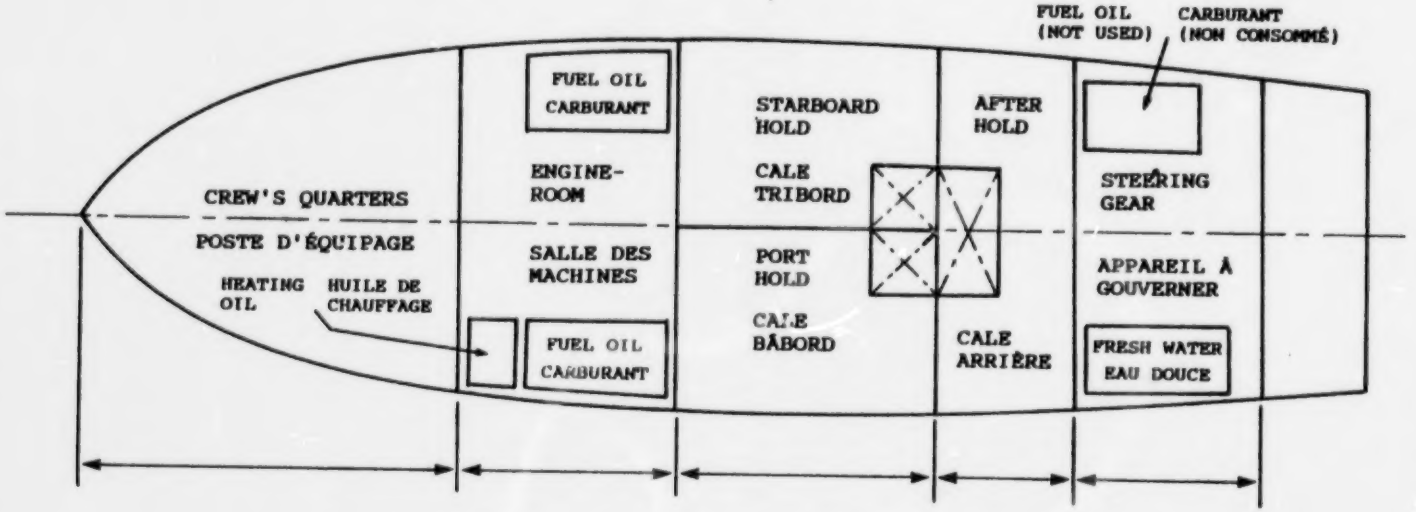
C FRESH WATER-STARBOARD EAU DOUCE-TRIBORD

(D) FUEL OIL-PORT CARBURANT-BÂBORD

LOCATION OF FISH HOLDS AND FUEL OIL & WATER TANKS

EMPLACEMENT DES CALES À POISSON ET DES CITERNES DE CARBURANT & D'EAU





"MISS JOYE"

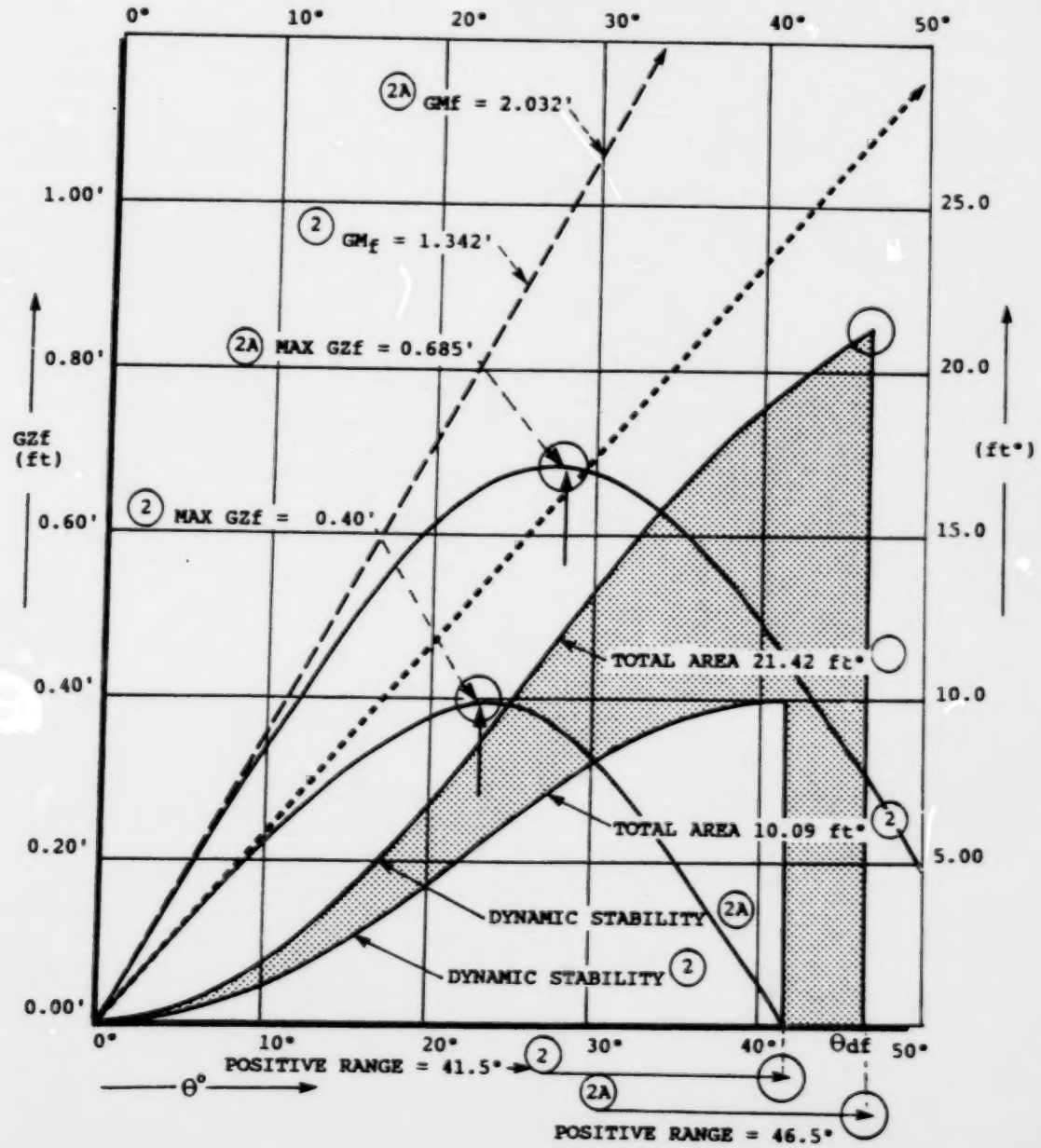
"MISS JOYE"

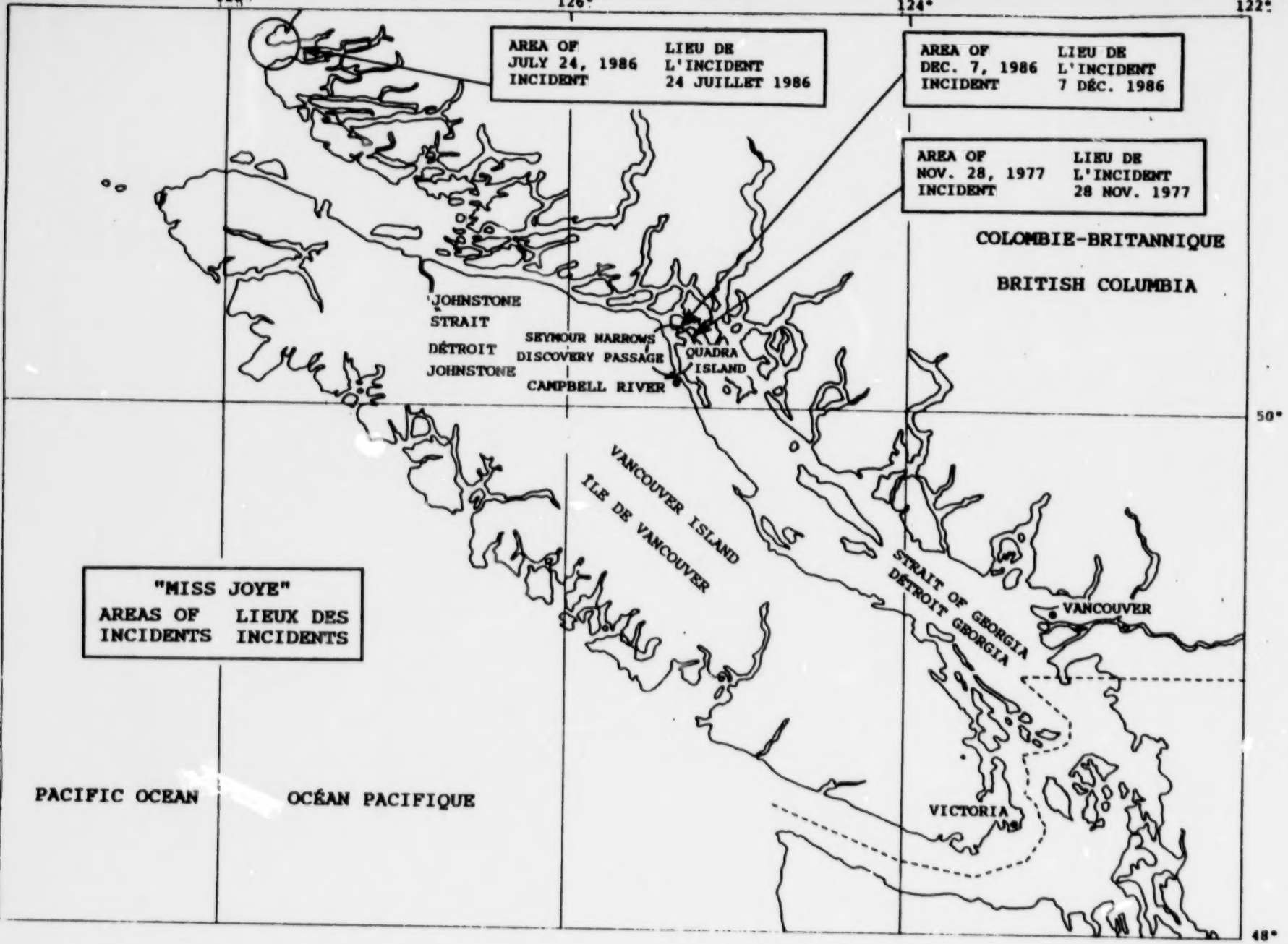
STATICAL AND DYNAMIC STABILITY COMPARISON OF VESSEL WITH SEINE NET ON DRUM OR BELOW DECKS, DECEMEBER 7, 1986

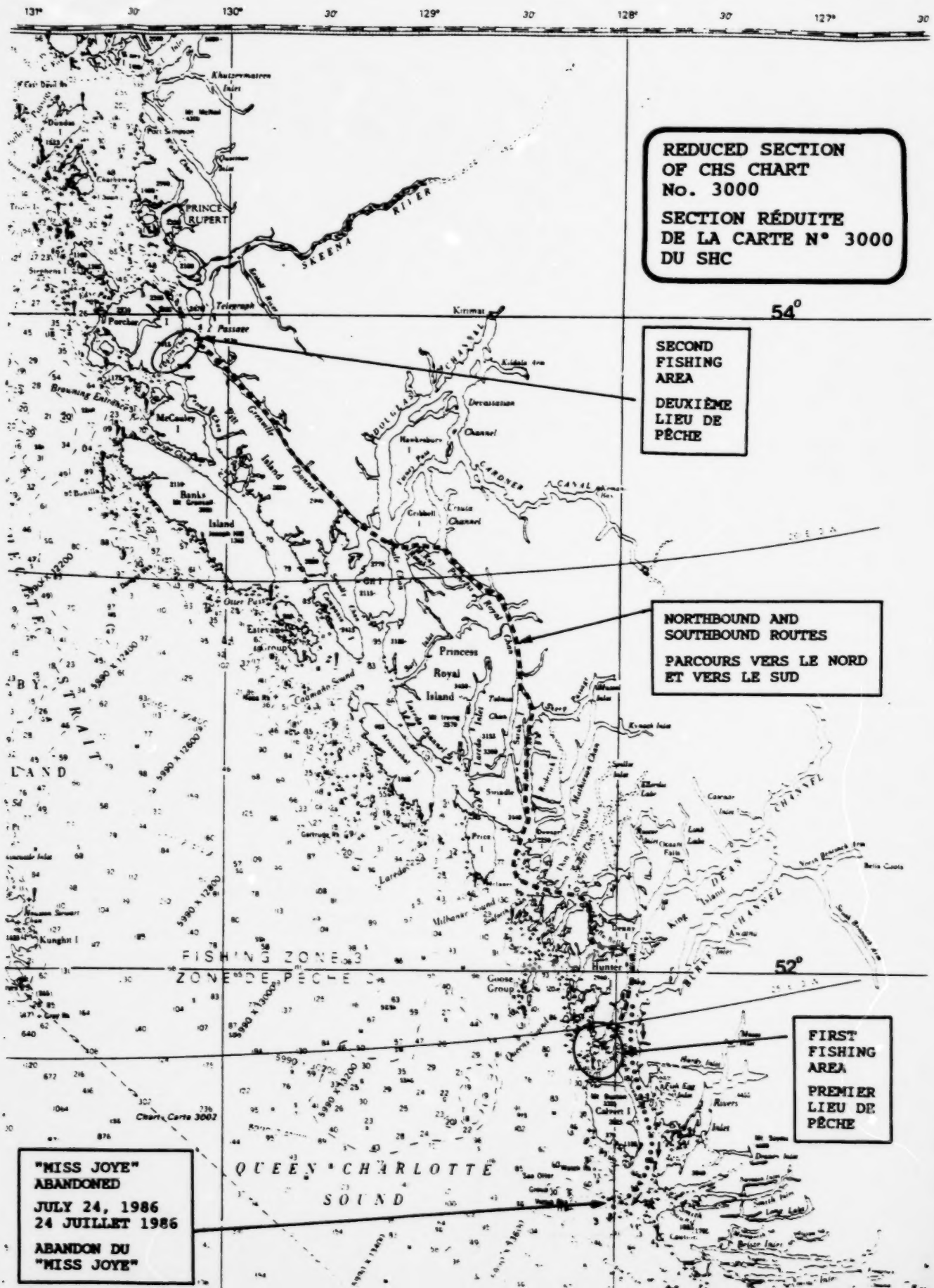
LOADING CONDITION DETAILS	COND N No.	TOTAL DYNAMIC STABILITY	MAXIMUM RIGHTING LEVER
ACTUAL CONDITION WITH NET ON DRUM	2	10.09 ft°	0.400 ft
POSSIBLE CONDITION WITH NET BELOW DECK	2A	21.42 ft°	0.685 ft

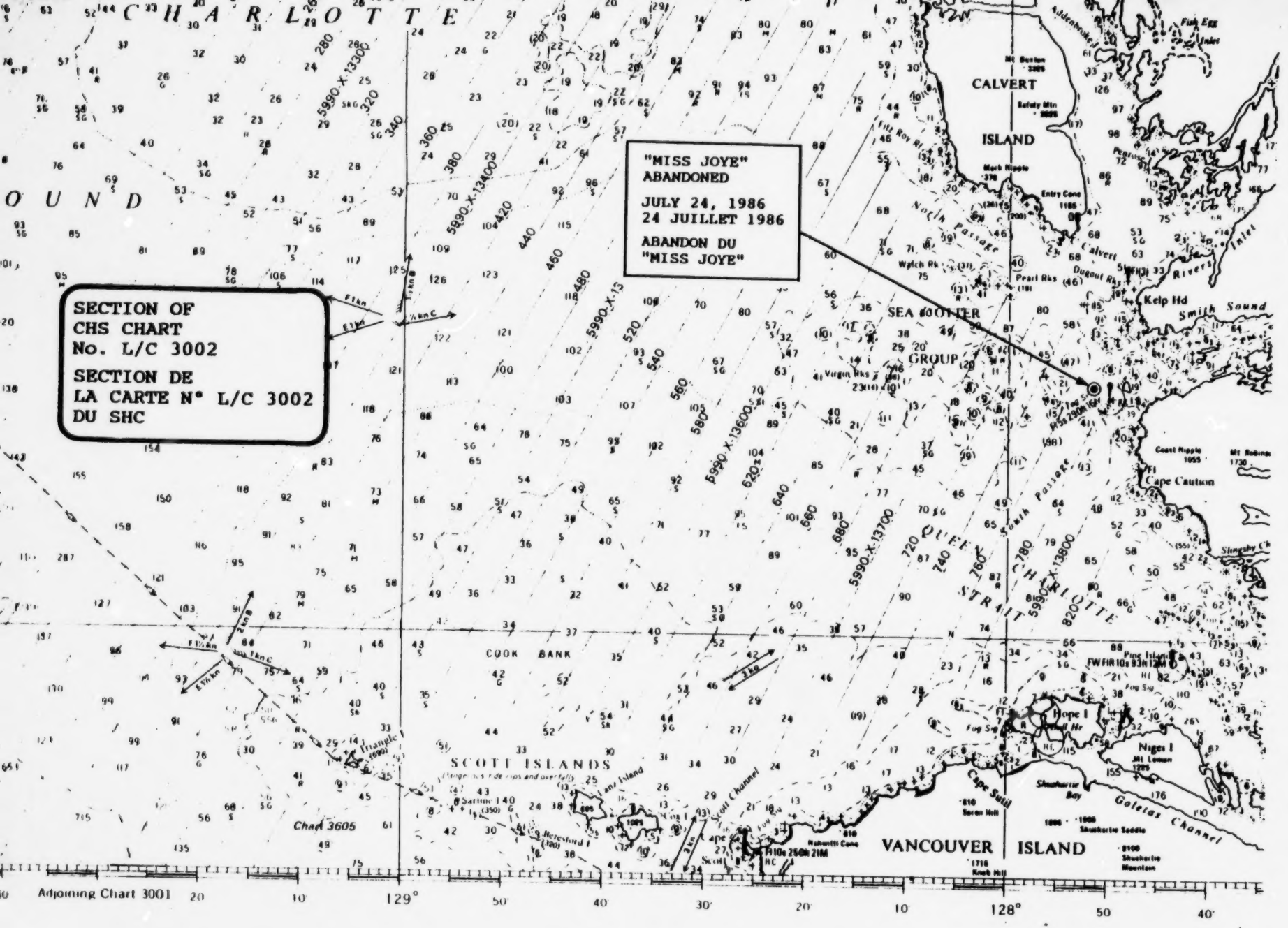
DYNAMIC STABILITY INCREASE POSSIBLE: 21.42/10.09 = +112%

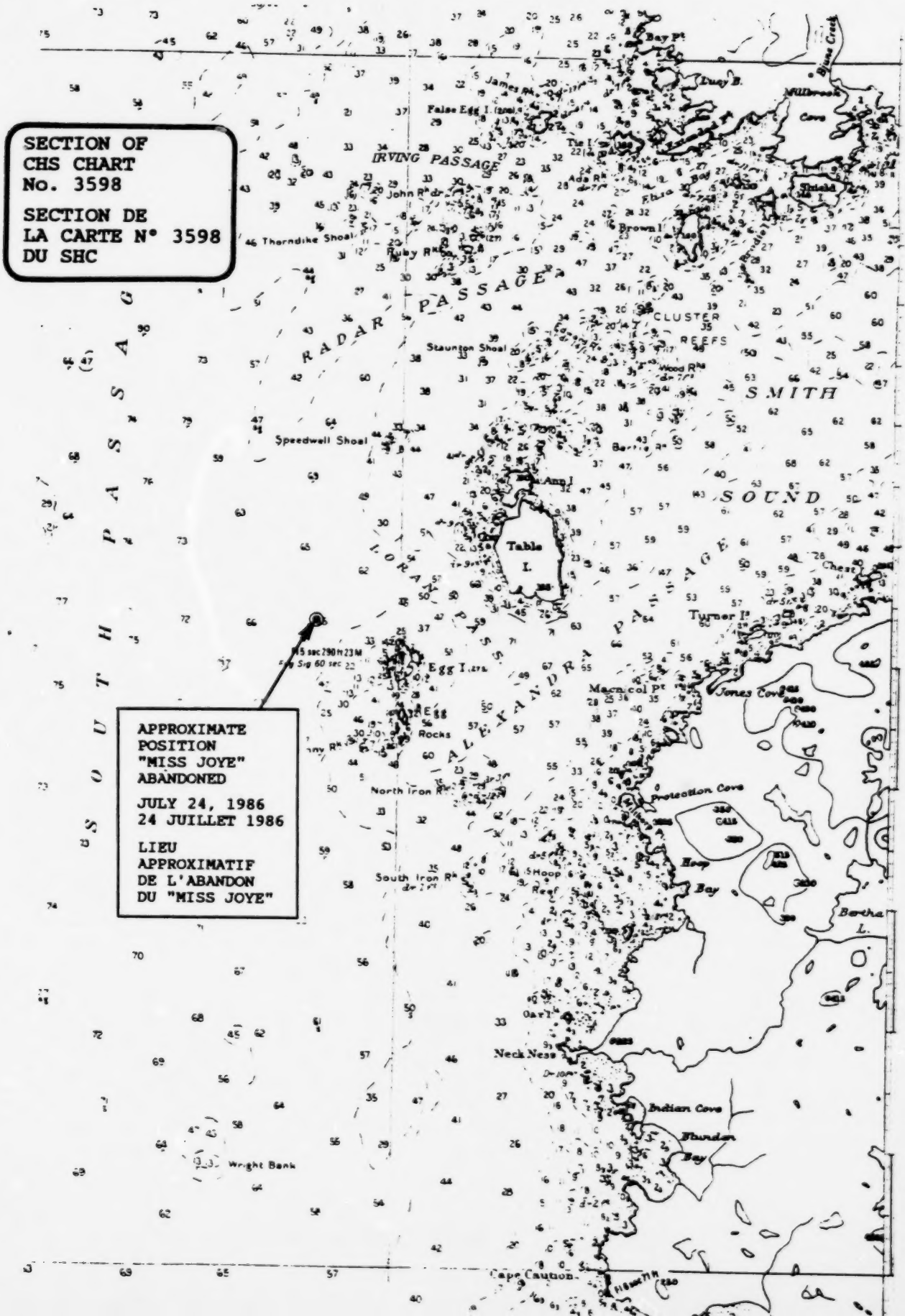
RIGHTING LEVER INCREASE POSSIBLE: 0.685/0.400 = +71%

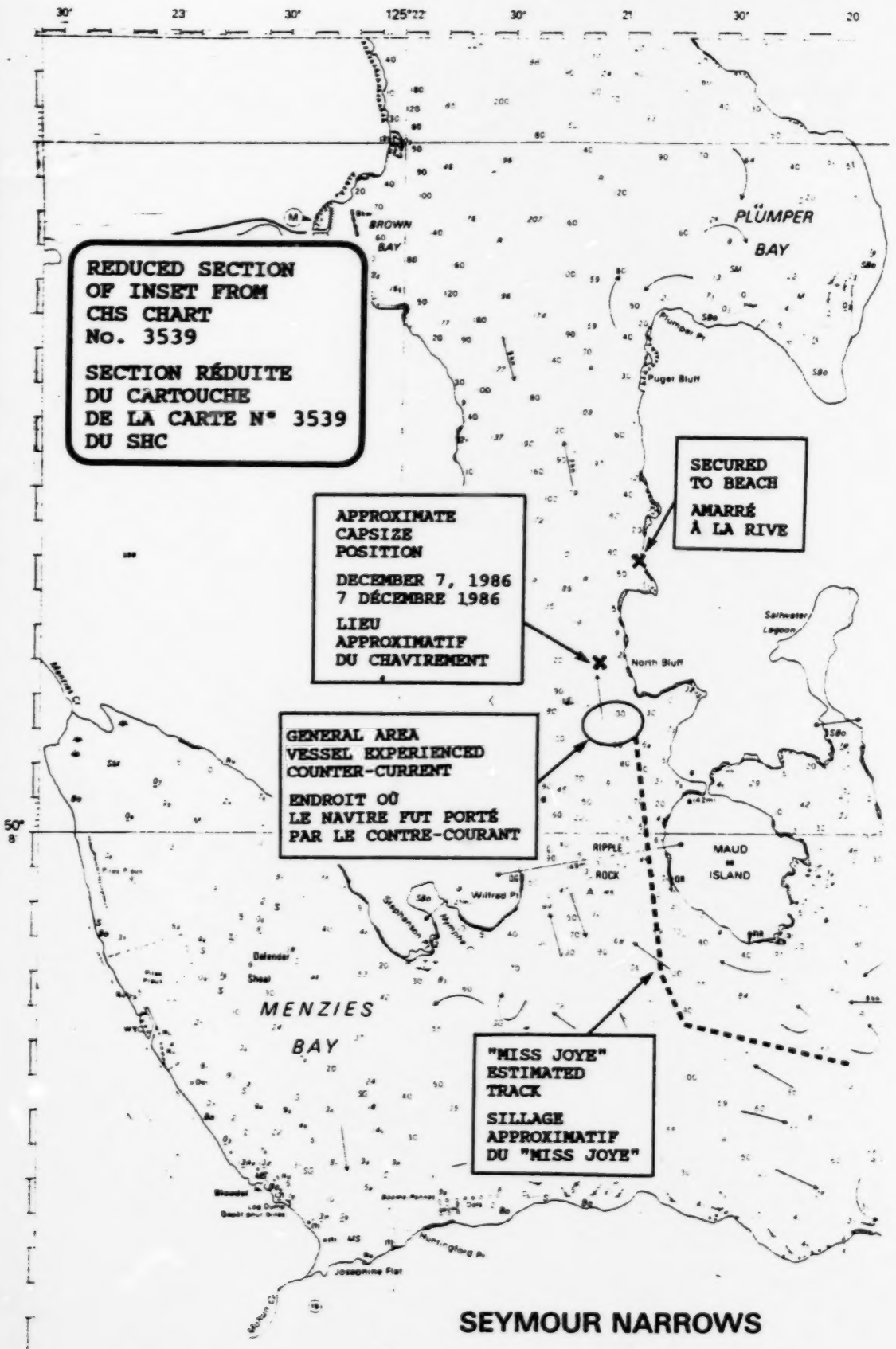



AREA OF JULY 24, 1986 INCIDENT
LIEU DE L'INCIDENT 24 JUILLET 1986
AREA OF DEC. 7, 1986 INCIDENT
LIEU DE L'INCIDENT 7 DÉC. 1986
AREA OF NOV. 28, 1977 INCIDENT
LIEU DE L'INCIDENT 28 NOV. 1977
"MISS JOYE"
AREAS OF INCIDENTS
LIEUX DES INCIDENTS
COLOMBIE-BRITANNIQUE
BRITISH COLUMBIA
JOHNSTONE STRAIT
DÉTROIT JOHNSTONE
SEYMOUR NARROWS
DISCOVERY PASSAGE
QUADRA ISLAND
CAMPBELL RIVER
VANCOUVER ISLAND
ÎLE DE VANCOUVER
STRAIT OF GEORGIA
DÉTROIT GEORGIA
VANCOUVER
VICTORIA
PACIFIC OCEAN
OCÉAN PACIFIQUE
126°
124°
122°
50°
48°


131° 30' 130° 30' 129° 30' 128° 30' 127° 30'
REDUCED SECTION OF CHS CHART No. 3000
SECTION RÉDUITE DE LA CARTE N° 3000 DU SHC
54°
SECOND FISHING AREA
DEUXIÈME LIEU DE PÊCHE
NORTHBOUND AND SOUTHBOUND ROUTES
PARCOURS VERS LE NORD ET VERS LE SUD
52°
FIRST FISHING AREA
PREMIER LIEU DE PÊCHE
FISHING ZONE 3
ZONE DE PÊCHE 3
"MISS JOYE" ABANDONED
JULY 24, 1986
24 JUILLET 1986
ABANDON DU "MISS JOYE"
QUEEN CHARLOTTE SOUND
PRINCE RUPERT
SKEENA RIVER
Princess Royal Island
Banks Island
Hunter
Chart/Carte 3007


"MISS JOYE"
ABANDONED
JULY 24, 1986
24 JUILLET 1986
ABANDON DU
"MISS JOYE"
SECTION OF
CHS CHART
No. L/C 3002
SECTION DE
LA CARTE N° L/C 3002
DU SHC
CHARLOTTE
SOUND
CALVERT
ISLAND
SEA OTTER
GROUP
QUEEN CHARLOTTE
STRAIT
COOK BANK
SCOTT ISLANDS
VANCOUVER ISLAND
Cape Caution
Kelp Hd
Smith Sound
Cape Scott
Goletas Channel
Adjoining Chart 3001
129°
128°


SECTION OF CHS CHART No. 3598
SECTION DE LA CARTE N° 3598 DU SHC
APPROXIMATE POSITION "MISS JOYE" ABANDONED
JULY 24, 1986
24 JUILLET 1986
LIEU APPROXIMATIF DE L'ABANDON DU "MISS JOYE"
IRVING PASSAGE
RADAR PASSAGE
SOUTH PASSAGE
SMITH SOUND
CLUSTER REEFS
Bay Pt
Duck B.
Millbrook Cove
False Egg I.
Tie I.
Ada Rk
Brown I.
John Rk
Ruby Rk
Thorndike Shoal
Staunton Shoal
Wood Rk
Speedwell Shoal
Table I.
Egg I.
Macnicol Pt
Jones Cove
Turner I.
Rocks
North Iron Rk
South Iron Rk
Hoop Reef
Protection Cove
Hoop Bay
Neck Ness
Indian Cove
Thunder Bay
Wright Bank
Cape Caution

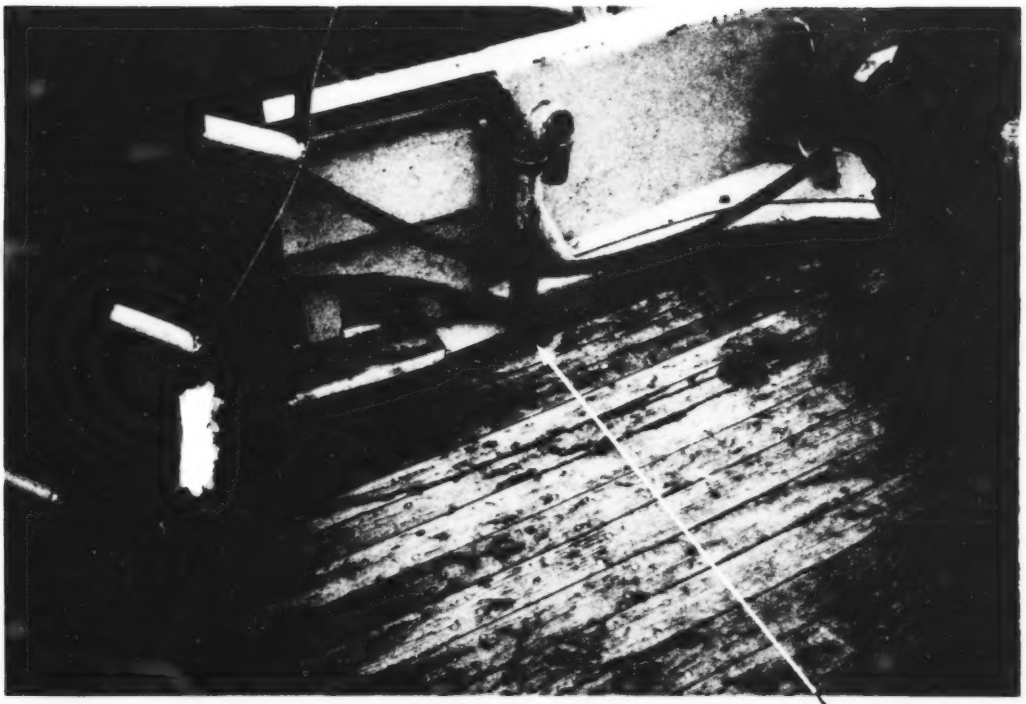


SEYMOUR NARROWS

Scale 1 20 000 Echelle

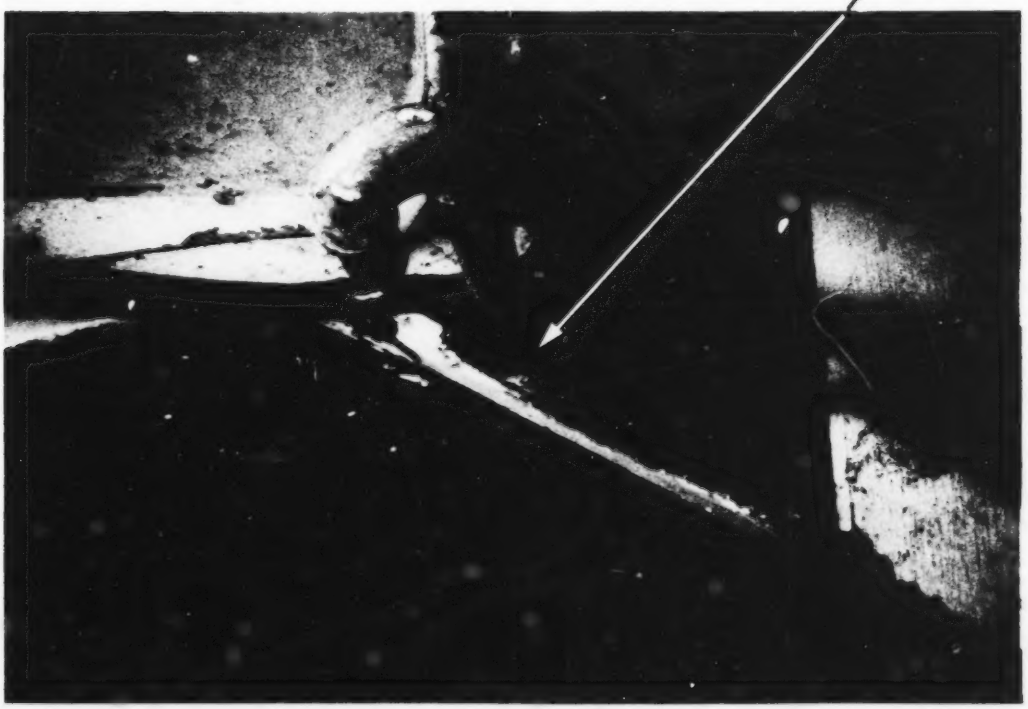
"MISS JOYE"

"MISS JOYE"



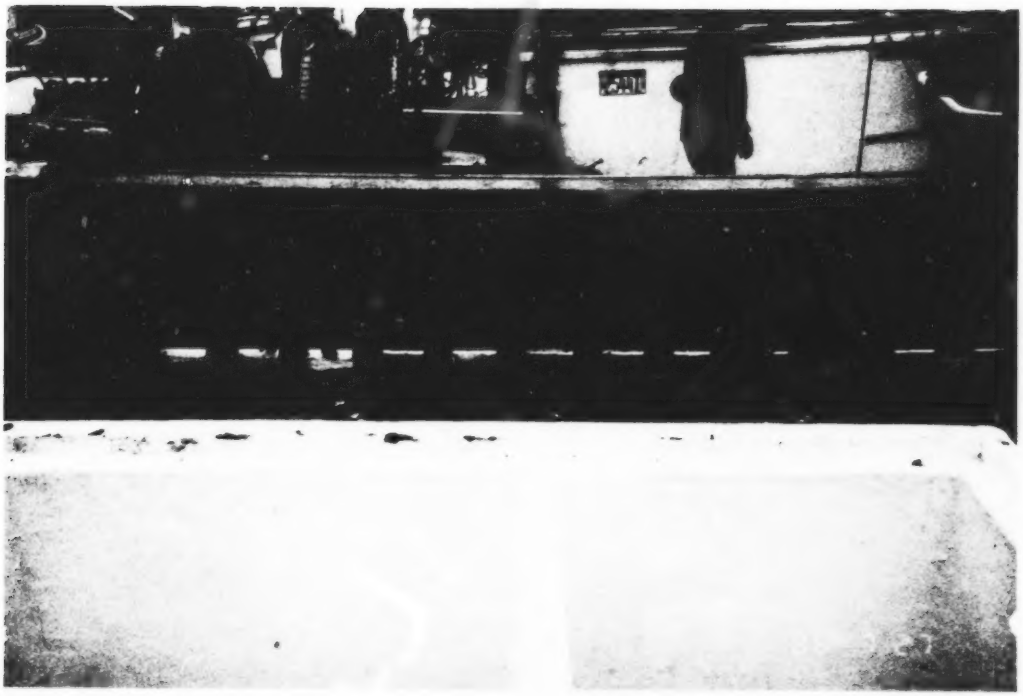
Un-caulked areas.
Endroits non-calfatés.

Air pipe from fresh water tank.
Tuyau d'air de la citerne d'eau douce.

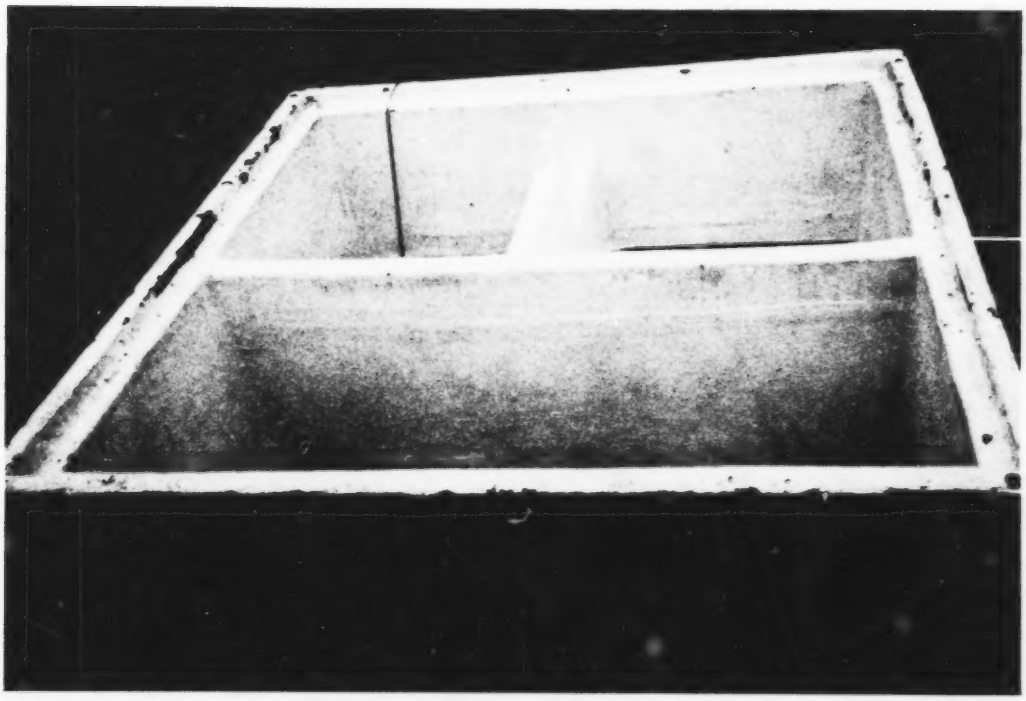


Air pipe from after diesel oil tank.
Tuyau d'air de la citerne d'huile diesel arrière.

"MISS JOYE"



Freeing port arrangement.
Arrangement de sabords de décharge.



Hatch and hold arrangement.
Arrangement de l'écoutille et de la cale.

"MISS JOYE"

Salvage operation.
Opération de sauvetage.

SEYMOUR NARROWS, DECEMBER 9, 1986.

LA PASSE SEYMOUR, LE 9 DÉCEMBRE, 1986.

Capsize area with similar tidal and weather conditions as experienced by the "MISS JOYE".

Lieu du chavirement dans des conditions de marée et de temps semblables telles qu'éprouvées par le "MISS JOYE".